IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

SPRINT COMMUNICATIONS COMPANY LP., *Plaintiff*, v. CHARTER COMMUNICATIONS, INC., *et al.*, *Defendants*.	C.A. No. 17-1734-RGA **PUBLIC VERSION**
SPRINT COMMUNICATIONS COMPANY LP., *Plaintiff*, v. MEDIACOM COMMUNICATIONS CORP., *Defendants*.	C.A. No. 17-1736-RGA **PUBLIC VERSION**
SPRINT COMMUNICATIONS COMPANY LP., *Plaintiff*, v. WIDEOPENWEST, INC. *et al.*, *Defendants*.	C.A. No. 18-361-RGA **PUBLIC VERSION**
SPRINT COMMUNICATIONS COMPANY LP., *Plaintiff*, v. ATLANTIC BROADBAND FINANCE, LLC *et al.*, *Defendants*.	C.A. No. 18-362-RGA **PUBLIC VERSION**
SPRINT COMMUNICATIONS COMPANY LP., *Plaintiff*, v. GRANDE COMMUNICATIONS NETWORKS, LLC *et al.*, *Defendants*.	C.A. No. 18-363-RGA **PUBLIC VERSION**

EXHIBITS 26-48 TO THE DECLARATION OF KELLY E. FARNAN IN SUPPORT OF CHARTER'S AND DEFENDANTS' OPPOSITION TO SPRINT'S MOTIONS FOR SUMMARY JUDGMENT AND MOTIONS TO EXCLUDE EXPERT TESTIMONY UNDER *DAUBERT*

CERTIFICATE OF SERVICE

I hereby certify that on June 30, 2020, true and correct copies of the foregoing document were caused to be served on the following counsel of record as indicated:

BY ELECTRONIC MAIL
Stephen J. Kraftschik
Christina B. Vavala
Polsinelli PC
222 Delaware Avenue, Suite 1101
Wilmington, DE 19801

BY ELECTRONIC MAIL
B. Trent Webb
Aaron E. Hankel
Ryan J Schletzbaum
Ryan D. Dykal
Jordan T. Bergsten
Lauren E. Douville
Mark D. Schafer
Samuel J. LaRoque
Maxwell C. McGraw
Thomas M. Patton
Lydia C. Raw
Shook, Hardy & Bacon LLP
2555 Grand Boulevard
Kansas City, MO 64108

BY ELECTRONIC MAIL
Robert H. Reckers
Michael W. Gray
Shook, Hardy & Bacon LLP
JPMorgan Chase Tower
600 Travis Street, Suite 3400
Houston, TX 77002

/s/ Kelly E. Farnan
Kelly E. Farnan (#4395)

EXHIBITS 26-28

REDACTED IN THEIR ENTIRETY

EXHIBIT 29

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF KANSAS

SPRINT COMMUNICATIONS CO., L.P. Plaintiff, v. COMCAST CABLE COMMUNICATIONS, LLC, et al., Defendants.	)	CONSOLIDATED CASES Case No. 11-2684-JWL
SPRINT COMMUNICATIONS CO., L.P. Plaintiff, v. CABLE ONE, INC., Defendant.	)	Case No. 11-2685-JWL
SPRINT COMMUNICATIONS CO., L.P., Plaintiff, v. TIME WARNER CABLE, INC., et al., Defendants.	)	Case No. 11-2686-JWL

DECLARATION OF LEONARD J. FORYS, PH.D.

I, Leonard J. Forys, declare as follows:

I. My Professional Background

1. The patents I reviewed (referred to below as Group 1 and 2) are in the general areas of telephone networks and packet network technologies with specific focus on signaling between them and the transport of voice over a virtual circuit packet-based network, ATM in

virtual circuit approach. As with the PSTN, for two end users to transmit data to each other, the network must first establish an end-to-end path on a switch-by-switch and call-by-call basis using a *virtual* circuit between them, as opposed to the actual circuits used by the PSTN. The end-to-end path consisting of virtual circuits is similar to the end-to-end actual path consisting of actual circuits established by the PSTN in that: (1) no user communication can take place until such an end-to-end path of virtual circuits is established, (2) all user communication between these two end users will use this path specified by the end-to-end path of virtual circuits and no other path for the duration of the call, and (3) nobody else can use the virtual circuits in the path for the duration of its existence. The difference is that, unlike the actual circuits used by the PSTN, a virtual circuit, as explained below, does not tie up transmission capacity when not in use.[22] In this way, a virtual circuit avoids the inefficiency of transmitting bursty data over an actual circuit, because in between the data bursts the virtual circuit, unlike an actual circuit, need not tie up transmission capacity of the transmission medium.[23]

54. First I will explain what a virtual circuit is. As in the PSTN, the network must first send appropriate signaling to each switch prior to transmitting the data so that each switch knows how to transmit the data it receives to the next switch on the path leading to the ultimate destination. A popular form of virtual circuit technology developed in the late 1980s was Asynchronous Transfer Mode (ATM). *The embodiments in the asserted patents deal exclusively with this form of data transport*. In ATM, a particular virtual circuit is specified by a pair of

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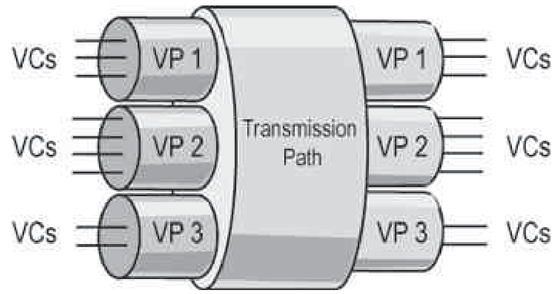
[22] Goralski, *supra*, at 32, Ex. 5 (In ATM "[*a*]*ll* traffic is sent based on demand; no traffic, no bandwidth drain.")

[23] In this way, virtual circuits are similar to my alternative postal system. Nobody else can use the sender's logical path in my example. Although when he is not sending letters to his mother this logical path is idle, he is not in fact tying up any space in the mail trucks or occupying the time of any mailpersons. He is merely occupying record-keeping space at each post office needed to maintain the path information.

numbers, a virtual path identifier (VPI) and a virtual circuit identifier (VCI), which identify respectively, a Virtual Path (VP) and a Virtual Connection (VC), as shown below:



Each VPI/VCI pairing is not a specific time slot as in the PSTN; instead it is merely a label used by the switches to define a logical or virtual circuit. Each virtual path (VP) is identified by a VPI and contains numerous virtual circuits identified by VCIs.[24] One physical transmission path (i.e. a wire) could be assigned to multiple VPIs and VCIs as illustrated above.[25] As part of the call setup process, each switch along the path from the origination to the destination will receive signaling that will enable each switch to update its switching table so it will know that any data arriving on, for example, VPI # 1 / VCI #5 will be sent out on VPI # 2 / VCI #3 and so forth throughout all of the remaining switches until the destination is reached.[26] If every switch in the path has the appropriate entries in their switching tables, the path will be fully set up to permit transmission of data. This is just like the alternative post office example.

55. Prior to transmitting data, it must be broken up into individual packets or cells that each include the VPI and VCI pair so that the switch knows what virtual circuit should be used for that particular cell. As the data is being transmitted, at each switch the switching

[24] Davidson, Robert P., *Broadband Networking ABCs for Managers: ATM, BISDN, Cell/Frame Relay to SONET* 90 (1994), Exhibit 6 ("Virtual channels are grouped together to form a virtual path.")
[25] *Id*. ("Many virtual channels may share a single physical link at the same time. For example, all the virtual channel belonging to a customer may be bundled within a single virtual path, simplifying network management.")
[26] The switching table is a control logic for the switch that specifies what outgoing virtual circuit is used to connect to an incoming virtual circuit.

mechanism may modify the VPI and VCI pair of the cell if the cell is to be switched onto a different outgoing VPI / VCI.

56. Unlike the PSTN, the circuit is *virtual*, meaning it need not have sole possession of a specific wire or time slot on a wire. At any moment in time when no data is being sent using a virtual circuit, no transmission capacity is used by the network for that virtual circuit and other virtual circuits can use that capacity instead. If instead actual circuits were used to transmit data, once the circuit was established, that transmission capacity could not be used for any other purpose — even during periods where no data was being transmitted over that circuit.

57. As indicated earlier, ATM was developed in the late 1980s to facilitate a more efficient transmission of data while retaining the ability to efficiently handle voice traffic. ATM provided a virtual circuit approach designed to work with a network known as the Broadband Integrated Services Digital Network (B-ISDN).[27] ATM uses fixed size transmission units referred to as cells. A cell consists of 53 bytes[28] divided into a 5-byte header and a 48-byte payload for the data to be transmitted.[29] One byte constitutes the Virtual Path identifier (VPI), 2 more bytes are used for the Virtual Connection Identifier (VCI) and the remaining bytes of the header are used for other purposes.[30] When a switch receives an ATM cell, it forwards the cell

[27] Davidson, *supra*, at 86-87, Ex. 6 (ATM "was designed as a telecommunications technology, specifically as the transport for Broadband ISDN (BISDN). . . . [ATM] transports continuous bit-rate traffic such as voice and video as well as noncontinuous traffic such as the bursty data frequently encountered with LANs.")

[28] A "byte" is a unit of digital information consisting of eight "bits." A "bit" is a unit of information that can have one of two values (commonly represented as a "1" or a "0").

[29] Davidson, *supra*, at 87, Ex. 6 ("All ATM switching uses standard 53-byte cells. Each ATM cell has a five-byte header that contains virtual circuit and virtual path identifiers.")

[30] *Id*. at 88 ("Virtual channel identifier (VCI)—the VCI (16 bits) [2 bytes] . . . defines a local logical connection between two ATM nodes. Virtual path identifier (VPI)—the VPI (eight bits) [2 bytes] is an aggregate of VCIs.")

from the sender and receiver are handled independently from each other[32]. Because there is no actual or virtual circuit, a packet cannot be sent merely by including an identifier of the path (there is no pre-arranged path). Instead, all packets must contain the address of the intended destination much like the real postal system which relies on explicit and unique addresses on each envelope. No signaling of any sort is needed on a call-by-call basis to communicate with each of the routers that may be used to route a packet from its origination to its destination. The routers are pre-programmed[33] so that they know how to send packets towards their ultimate destination by reading the packet's address. To receive service from the network the user simply hands to the network packets that contain in their header the destinations to which they are to be delivered. (This is analogous to dropping a letter in the mailbox.) No end-to-end path of any sort gets established within the network. The best example of a data network that offers routing based on the explicitly addressed packets instead of establishing paths for each call is the Internet. Addressing and packet formats are defined in the Internet Protocol (IP) specification, originally designed by Cerf and Kahn in the mid seventies. The US Defense Advanced Projects Agency (DARPA) primarily supported early work on the Internet and in fact experiments in the 1970s demonstrated the feasibility of transporting voice using normal telephones with this type of protocol.

63. People have recognized since the inception of datagram based networks that they can also be used to transmit voice by including digitized voice in the packets as the transmitted

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[32] This can result in packets being received out of order at the destination. Special reassembly logic is needed to reorder the received packets.

[33] Routers typically obtain network configuration and construct routing tables by themselves in a distributed fashion using a variety of techniques, but they are not constructed on a call-by-call basis and do not process call signaling. For example, a new element in a particular portion of the network would flood the network indicating its availability. Also, elements in the network periodically flood the network with availability updates. All routers would update their routing tables based on the various links that the availability packets arrived on.

data from the sender to the receiver, although in the mid 90s ATM was the almost universal choice. (See supra, footnote at the end of paragraph 52.)

IV. <u>The Patents</u>

A. Group 1 Patents

1. Group 1 Patents are Directed to Networks that Establish Complete End-to-End Paths on a Call-by-Call Basis.

64. As discussed in paragraphs 58 to 60 above, the patents assert that switches in networks that establish end-to-end paths which are responsible both for controlling the establishment of the end to-to-end path and for carrying voice traffic through the switches after the end-to end path is established.

65. The Group 1 Patents express views regarding the operation of the existing circuit switch based PSTN technologies and virtual circuit switched based ATM technologies at the time of the alleged invention. As explained in the preceding sections, circuit and virtual circuit based networks require setting up the circuits (or virtual circuits) between each of the network elements prior to transmitting user communication over the end-to-end path that is established during the set-up phase. According to the patents, both types of networks (PSTN and virtual circuit-based) use switch-based signaling on a call-by-call and switch-by-switch basis to set up an end-to-end path prior to transmitting any voice or data.

66. The Group 1 Patents define express views regarding the operation of this "communications path" as "the combination of connections and network elements that physically transfers the information between points." ('3,561 Pat. 5:16-18; *see also id.* at 1:32-34.) The term "connection," according to the Group 1 Patents, refers to "the media between two network elements that allows the transfer of information." (*Id.* at 4:64-65.) A connection can "correspond to . . . a DS0 circuit" in the PSTN or "a virtual channel in an ATM system." (*Id.* at

5:3-8.) "Switches provide the primary means where different connections are associated to form the communications path." (*Id.* at 1:35-36.) The Group 1 Patents acknowledge that this process of setting up an end-to-end path "is well known in the art." (*Id*. at 2:1.) The end-to-end path to which the Group 1 Patents are referring is a unique path defined during call set-up over which the voice for that call will travel exclusively.

67. The Group 1 Patents refer to the process of setting up the communication path as "communication control" and explain that it involves "the selection of network elements such as switches or other devices which will form part of the communications path" as well as "the selection of the connections between the network elements." (*Id.* at 1:37-43.) This necessarily occurs on a call-by-call basis based on the signaling for the call and the status of the network. According to the patents it is the switches that "control these selections" and often they are "selecting the next switch that will make further selections" to further extend the path towards the ultimate destination. (*Id.* at 1:49-55.) The switches use "signaling" to assist in establishing the path through each intervening switch: "The first switch will typically process [the signaling tones from the dialed number] and will select other network elements such as a second switch. The first switch signals the second switch and establishes a connection between the switches. The second switch then selects the next network element, signals that network element, and establishes a connection to that network element. This process is well known in the art. The connections and signaling thus proceed from switch to switch through the network until a communications path is established between the first and second points." (*Id.* at 1:62-2:4.)[34]

[34] Thus the Group 1 Patents distinguish between "signaling," which is used to set up an end-to-end path, and the actual user communications which will traverse this path once it is fully established

another telephone number. This is done by querying a remote database (a Service Control Point or SCP).[35] (*Id.* at 12:32-35.) Without access to such "800 platforms" accessible only through narrowband switches, broadband switches could not control the translation of a "1-800" number into the actual telephone number that must be used by the switches to establish the end-to-end path.

73. **Billing.** Similarly, the Group 1 Patents claim that broadband switches cannot perform the billing function for a call or determine how to loop in a narrowband switch during establishment of the end-to-end path to perform that task. (*Id.* at 2:63-3:4.) In 1994, many calls were billed based on the duration of the call and the distance between the parties but allegedly since broadband switches could neither perform this task themselves nor determine a path that included a narrowband switch that could perform this task, this presented yet another obstacle according to the Group 1 Patents to developing a full service telephone system that married broadband and narrowband capabilities. (*Id.* at 21:11-28.)

74. **Call routing.** Lastly, ATM switches allegedly could not perform even the basic call routing task required to connect a broadband switch to a narrowband switch for "800" number processing, billing or establishing an end-to-end path for a call originating and/or terminating in the (narrowband) PSTN on a call-by-call basis. (*Id.* at 2:63-3:4.) In other words, according to the Group 1 Patents, broadband switches lacked the ability to route any particular call, on a call-by-call basis, to a narrowband switch if necessary for any reason. This rendered the interface between broadband and narrowband "a rigid access pipe" that could not be adjusted on a call-by-call basis. This might work for a telecommunications network that was relatively predictable like the famous "red telephone" hotline between Washington and Moscow or a link

[35] Although SCP's are "network elements" according to the Group 1 Patents ('3,561 Pat. 458-60), they are not part of the communication path established for the user communication.

between various remote offices of a corporation so that all calls using a four-digit extension would reach any other phone in the company, even those in distant cities. It allegedly would not work for a full service telephone network that needed to route calls dynamically all over the country at any given moment.

5. Simply Combining PSTN and Broadband (ATM) Networks Does not Overcome the Limitations of Broadband Networks.

75. Combining broadband (ATM) and narrowband networks potentially yields some of the advantages of both networks, such as giving narrowband networks access to broadband speeds, but according to the Group 1 Patents this still does not overcome the problem that broadband (ATM) switches do not include the features needed for voice. Even if the broadband and narrowband networks are connected, "[a]t present, the ability of these switches to signal each other is limited," creating "a major obstacle in any attempt to interface the two networks" as required to make use of narrowband switch features such as "800" platforms and billing. ('3,561 Pat., 3:12-18.) What is needed, according to the Group 1 Patents, is an "intelligent interface" between the narrowband and broadband switches. (*Id.* at 3:10-20.)

76. In other words, according to the Group 1 Patents, ***the broadband (ATM) and narrowband switches lack the "intelligence" needed to decide when and how they should signal each other***, so that a narrowband switch could include a broadband switch—or a broadband switch could include a narrowband switch—in the end-to-end path being set up for a particular call. Because of this limitation, the Group 1 Patents explain, broadband (ATM) switches cannot loop in narrowband switches to overcome the shortcomings of broadband (ATM) switches, including broadband's inability to translate "800" numbers and perform normal billing functions on a call-by-call basis. Likewise, narrowband switches cannot decide on a call-

by-call basis to include broadband (ATM) switches in a caller's path to overcome the speed limitations of narrowband switches.

77. The central reason, according to the Group 1 Patents, that this limitation cannot be overcome is because, like narrowband switches, broadband (ATM) switches are burdened with the dual tasks of establishing the end-to-end path and actually carrying the user traffic over the path once it has been established. "The performance of both of these tasks by switches places limitations on a telecommunications network." (*Id.* at 2:56-58.) "The reliance on switches to both perform communication control and to form the a [sic] part of the communication path results in impediments to developing improved networks. . . . At present, there is a need for a portion of the communication control processing to be independent of the switches that form a part of the communications path." (*Id.* at 3:21-31.)

6. The Alleged Solution is to Create a Communication Control Processor (CCP).

78. The Group 1 Patents claim that the solution to integrating narrowband and broadband (ATM) switches into a single functional network that can perform all of the tasks of the traditional telephone network, including "800" number calling, billing and basic call routing can be solved by creating an allegedly new and "independent" entity that handles "communication control processing." ('3,561 Pat 3:28-31.)

79. The Group 1 Patents attempt to describe such an entity: "[i]n FIG. 1, Telecommunications System 110 comprises a communication control processor (CCP) 120 . . . ." (*Id.* at 5:29-30.) "Communication control," the group 1 patents explain, "is the process of setting up a communications path between the points" and includes "the selection of network elements

such as switches or other devices which will form part of the communications path."[36] (*Id.* at 1:37-38.) "Communication control also comprises the selection of the connections between the network elements." (*Id.* at 1:41-43.) Thus the CCP controls the overall setting up of the end-to-end communications path by processing the incoming signaling, selecting one or more switches, other network elements or connections and communicating that decision to the broadband switches. The CCP has an overview of the network from a position outside any path it will set up for a call. It determines when broadband (ATM) switches and virtual circuits should be in the paths and when TDM circuits and switches (narrowband) should be in the paths. This is how i "controls" establishment of the paths on a call-y-call basis. What and how many things in the network it must select vary on a call-by-call basis.[37] Every embodiment in the specification (see Figures 1-3) uses the same CCP which controls establishment of an end-to-end path with TDM and virtual circuits depending on what is needed given the particular network that it controls and the specific call being placed ('3,561, 21:11-67.)

80. The CCP is in fact the only thing which the Group 1 Patents purportedly add to the prior art, and is what I understand the specification asserts claim to be the invention. The Group 1 Patents admit the rest of the components, such as the switches, muxes and STPs, were already known. (*Id.* at 10:7-17.) Even though the Group 1 Patents attempt to describe their solution to the stated problem as the creation of a CCP, the only explanation they provide as to

[36] "A communications path is the combination of connections and network elements that physically transfers the information between points." ('3,561 Pat. 5:16-18.)

[37] Because the CCP controls the establishment of the end-to-end path, even in the simplest scenario it must still select at least one network characteristic and always has the ability to signal other network elements: "The CCP might select all of the connections, a portion of the connections, or none of the connections, again leaving the elements to select the remainder. The CCP may select combinations of the above options, but **the CCP will always select at least one network characteristic.**" (*Id.* at 24-29; 14:7-9 ("the CCP receives signaling and has the ability to signal other network elements.")

what constitutes a CCP is a general purpose computer that has appropriate software.[38] The Group 1 Patents state that "[o]ne example of a CCP device" the only example these patents provide—"would be a Tandem CLX machine configured in accord with this disclosure of the present invention." (*Id.* at 13:50-52.) A Tandem CLX is simply a general purpose computer that could not serve as a CCP without any special programming.[39] The Group 1 Patents, however, do not provide any software or even algorithms that could be used to program a general purpose computer to perform the various functions the patents attribute to a CCP. For example, Figures 4-8 of the Group 1 Patents purports to depict the workings of a CCP, yet none of these figures or the associated disclosure in the specification ever disclose how the many functions performed by the CCP are implemented. Furthermore, I note that the CCP, and the Group 1 Patents, are only directed to setting up the end-to-end path for user communications, not the actual sending of those communications once such a path is established.

7. The Group 1 Patents Describe the CCP's Operation Through an Example Based on '3,561 Pat. Figure 3

81. The Group 1 patent specification never really describes what a CCP is other than to state "[o]ne example of a CCP device would be a Tandem CLX machine configured in accord with this disclosure of the present invention." ('3,561 Pat. 13:50-52.) A Tandem CLX is simply a highly reliable general purpose computer. "[C]onfigured in accord with this disclosure" means that software, which the patent does not disclose even in the form of algorithms, is created and

[38] In fact, every figure in the Group 1 Patents relates to various embodiments for using this CCP and every reference to use of "signaling messages" is always in the context of establishing a single communication path for the entire call. Figures 1-3 each include a CCP that controls the establishment of an end-to-end communication path through the network on a call-by-call and switch-by-switch basis. Furthermore, in each case the CCP is not itself part of the path for the call.

[39] Tandem Computers, *NonStop CLX System Management Manual* 2-1 (1987), Exhibit 7 ("The NonStop CLX is a compact minicomputer system designed to operate in a typical office environment.")

loaded onto the computer to turn it into a CCP.[40] Figure 8 proves the only disclosure of any details regarding the CCP's processing. ('3,561 18:52-20:14.) The specification states that the CCP contains tables used to make selections but never discloses the tables. The specification states only that "[t]hose skilled in the art will recognize the numerous factors that can be used to design and load the tables" contained in the CCP. ('3,561 19:32-33.)

82. The Group 1 Patents specification, however, do provide some discussion of what a CCP is capable of doing, even if it does not disclose how it can perform these tasks.

83. Figure 3 of the Group 1 Patents shows a "Telecommunications Network," which I have surrounded with a red line, below.[41] Figure 3 is the only embodiment where the CCP is used to provide egress from the network. This network represents a long distance, or interexchange carrier (IXC), network. Switches 360, 362, 364, and 366 within this network are broadband (ATM) switches. (*Id.* at 10:7-11.) The CCP 350 is highlighted in orange. Switches 325 and 335 are local telephone company (referred to as local exchange carrier or LEC) switches, situated outside the long distance network. They use TDM circuit switching technology, as in the PSTN. (*Id.* at 10:59-61.) Switches 370 and 375 are also circuit switches,

[40] For example, although figures 5-7 purport to depict flow diagrams of the alleged invention, elements 515, 615 and 710 are each labeled "process," however the Group 1 Patent does not disclose any such process. See, e.g., '3,561 Pat. 15:26-39: ("The CCP processes the information it [sic] has received in box 515. Processing also entails the use of programmed instructions in the CCP, and might even include the use of information retrieved from a remote database, such as an SCP. The selections are then made as shown in box 520. These selections specify network characteristics, such as network elements and/or connections. As stated above, The CCP may only select a portion of the network characteristics and allow the points or the switches to select the remainder. It should be pointed out that the information used in processing is not limited to that which is listed, and those skilled in the art will recognize other useful information which may be sent to the CCP.")

[41] I have added coloring and comments to explain Figure 3 from the Group 1 Patents in several figures included in the text of this declaration over the next few pages. In addition, an animation (Group 1 Patents) has been prepared based on my declaration which further illustrates the points made in this section. I understand that this animation will be submitted along with my declaration.

though they are located within the long distance network. (*Id.* at 10:7-11.) The "STP" devices shown both inside and outside the long distance network are "signal transfer points," which are used to send signaling. (*See id. at* 2:16-24.) SCP 355 (or service control point) is a database, which contains information that is used to establish an end-to-end path in a telephone network. (*Id.* at 2:10-15.)

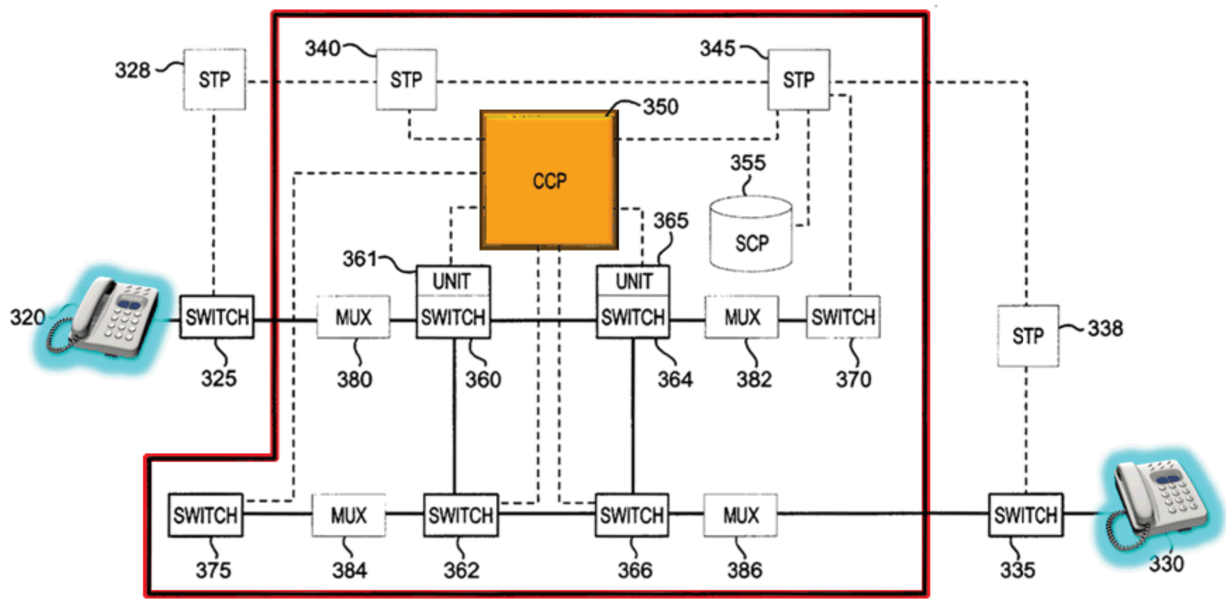


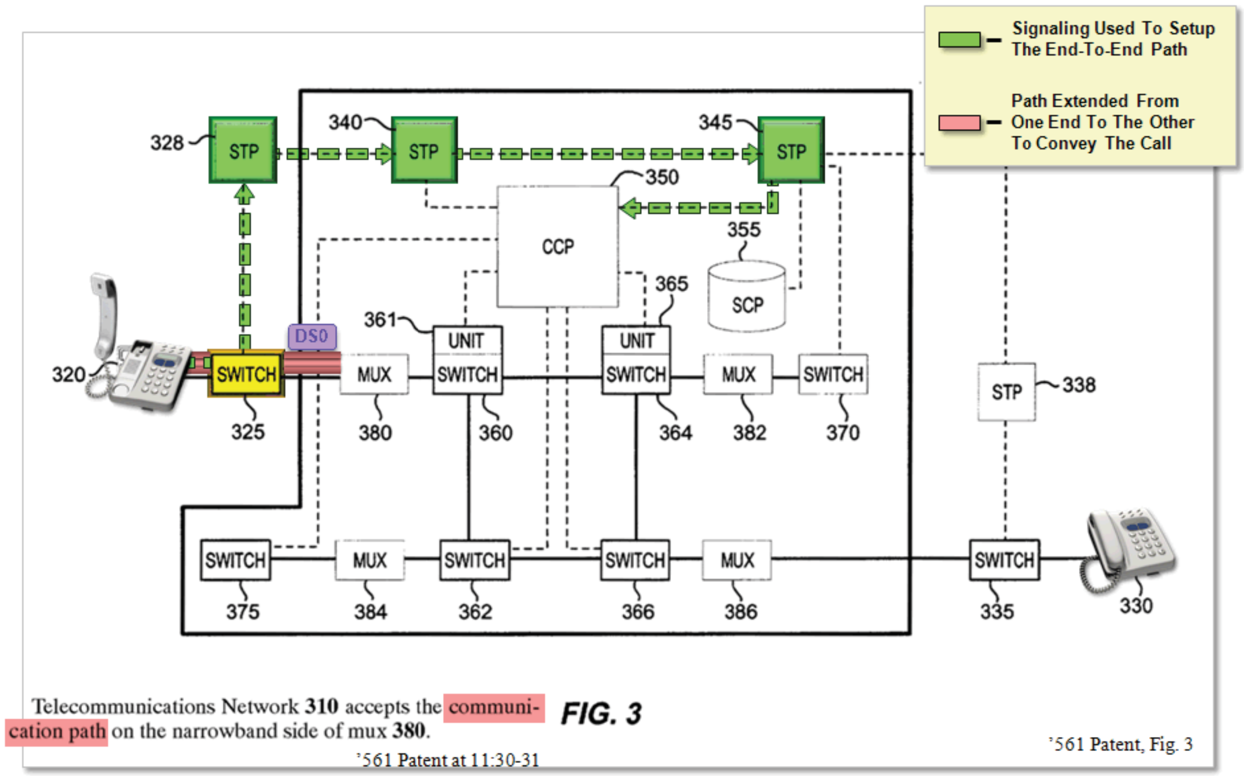
FIG. 3

'561 Patent, Fig. 3

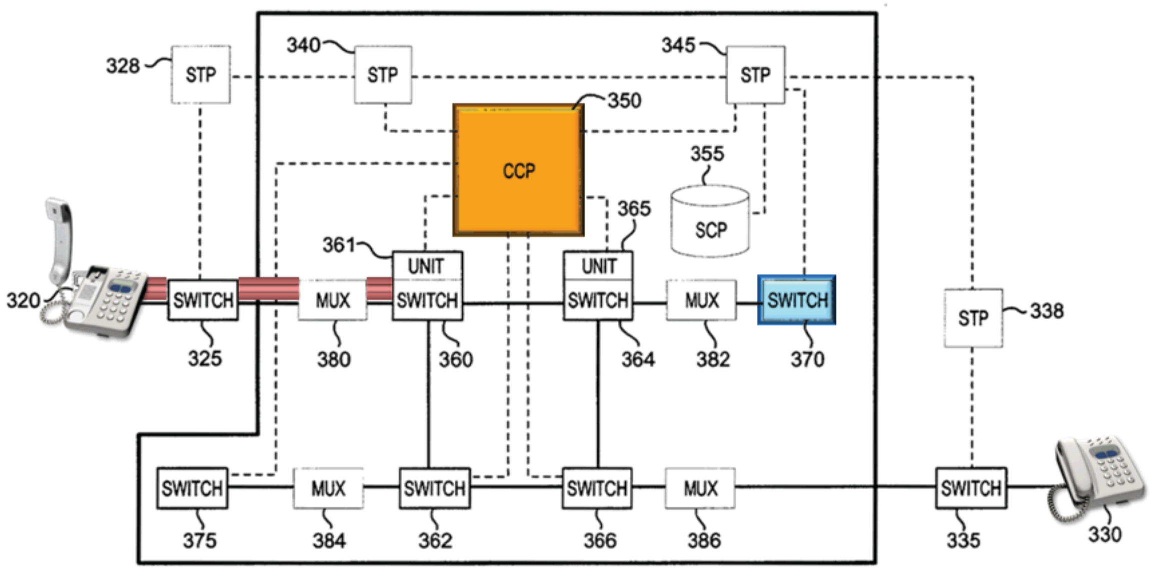
84. Using Figure 3, I will provide an overview of how a call is made, and how the end-to-end communication path is established, as described in the specification of the Group 1 Patents. (I have provided a DVD that contains an animation which similarly illustrates the example of Figure 3 of the Group 1 Patents.) First, a calling party 320 dials a phone number of a called party 330 (which could be a toll-free "800" number, or a number requiring billing by the interexchange carrier). In the same manner as I described above with respect to the PSTN, the calling party 320 is connected to his or her local telephone (LEC) switch 325 via a local loop.

The LEC switch 325[42] receives the signaling for the call (in the form of the dialed telephone digits), selects a DS0 trunk to the long distance network and sends SS7 signaling for the call to STP 328 so that the path of the call can be extended. From STP 328, the signaling travels into the long distance network to STP 340, then STP 345, and finally to the CCP. (*Id.* at 11:18-24, 37-41.) Below I have illustrated the path of the signaling with green arrows and the intended path for the call as a pink tube. As can be seen from each successive depiction of Figure 3 in the next few pages of my declaration, one can see how the CCP exercises its control over the extension of the path--made up of both virtual circuits (VC) and TDM circuits (DS0). The specification does not explain[43] why the signaling travels to STP 345 first, rather than traveling directly from STP 340 to the CCP. Instead of leading to another circuit switch, in accordance with my description of the PSTN, the DS0 selected by switch 325 is connected to mux 380. The mux maps and converts the incoming DS0 (circuits used by the narrowband switch) into an outgoing virtual channel (VC) which is a virtual circuit that will be understood by ATM switch 360. (*Id.* at 11:33-36.) In other words, it translates the call between two communication technologies. As there is no signaling shown going to mux 380 in Figure 3, I understand that there is a fixed 1-1 mapping between any particular incoming DS0 and its corresponding outgoing virtual channel. (*See id. at* 10:28-34.)

[42] A LEC switch is a narrowband switch used by a local exchange carrier (i.e. local telephone company).
[43] The specification indicates that SCP 355 which is connected to STP 345, may be used by the CCP to gather routing information, but it is not necessary that the CCP be first connected to STP 345 in order to be able to do so. The CCP could just as well as have sent a query to SCP 355 via STP 340.



85. Once the CCP receives the call signaling, it will determine what must be done to establish the end-to-end path for the call. One determination the CCP makes is whether the call will need services provided by narrowband circuit switches, such as 800-number translation or billing services. (*Id.* at 11:45-47, 54-55.) If a narrowband circuit switch is needed in the end-to-end path for the call, the CCP will select which one will be used. (*Id.* at 11:45-47.) The CCP may consult the SCP database in making these determinations. (*Id.* at 11:39-42.) Continuing the example of Figure 3, the CCP selects narrowband circuit switch 370 (highlighted below in blue) to be included in the end-to-end-path for the call.



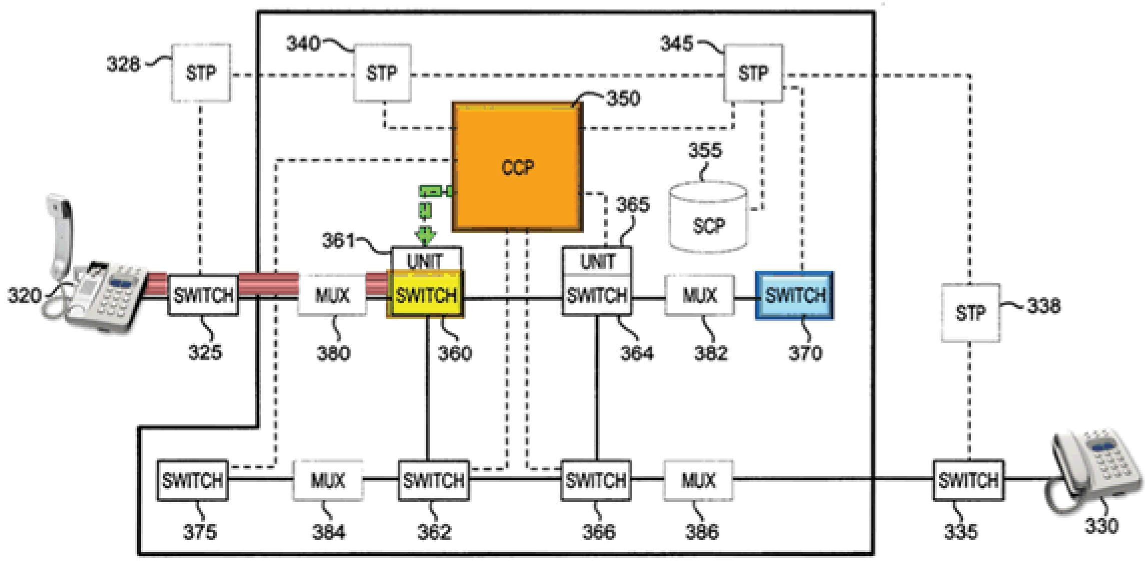
Assuming CCP 350 selects narrowband switch 370, it would also select a DS0 port on narrowband switch 370 to accept the connection.

'561 Patent at 12:12-14

FIG. 3

'561 Patent, Fig. 3

86. Once the CCP has determined which circuit switch (if any) within the long distance network will be used, it signals broadband (ATM) switch 360 (as indicated with the green line below) with the identity of the selected circuit switch 370 as well as the specific port on switch 370 to be used. (*Id.* at 12:5-17.) The nature of the signaling is not disclosed. The only thing that the patent mentions is that it is "new signaling" (*id.* at 6:17-21), without specifying the protocol, the message sent or any details. The patent does not disclose how the broadband (ATM) switches are to implement these signals, simply that they do so. According to the Group 1 Patents, the CCP is capable of selecting every switch and every connection to be used to extend the path of the call to switch 370, but it need not do so in every case. (*Id.* at 11:61-12:4; 7:25-28.)



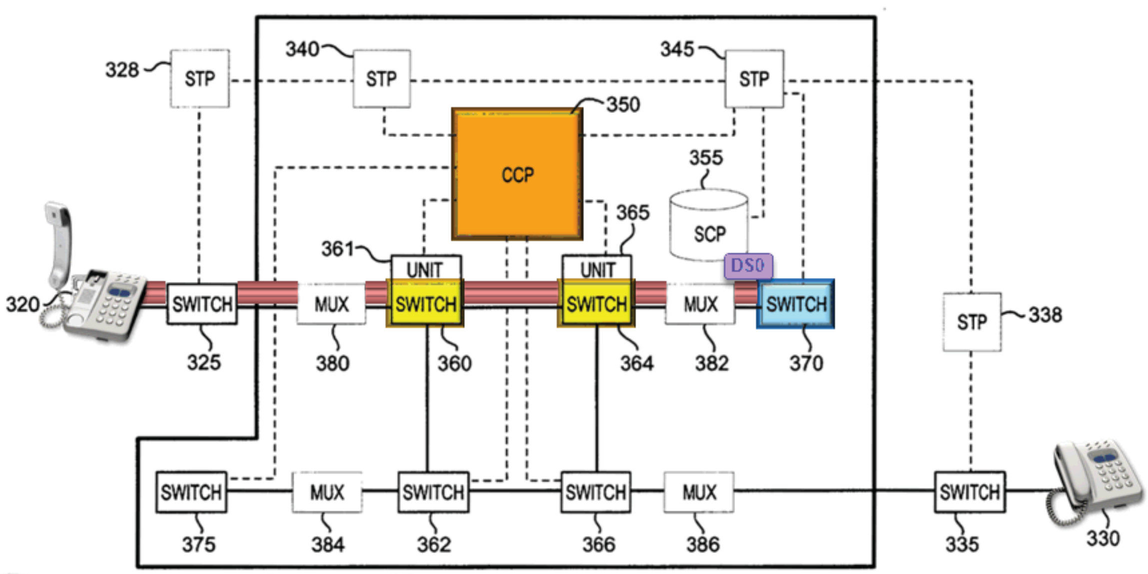
CCP 350 would then signal broad-band switch **360** through interworking unit **361** to farther the communications path to the selected DS0 port on narrow-band switch **370**.

'561 Patent at 12:14-17

FIG. 3

'561 Patent, Fig. 3

In the example of Figure 3, the CCP "allows" the broadband (ATM) switches to extend the path to switch 370 on their own without specifying how the signaling is done to allow this to happen. (*Id.* at 11:64-67.)



Broadband switch **364** would further the com-munication path to through mux **382** to access the specified DS0 port on narrowband switch **370**.

'561 Patent at 12:24-26

FIG. 3

'561 Patent, Fig. 3

87. The ATM switches extend the call path to switch 370 through ATM switches 360 and 364 and mux 382 as shown above. The ATM switches signal each other independently of the CCP to further the path. (*Id.* at 12:20-26.) In the reverse process of what I described with respect to mux 380, mux 382 converts the virtual circuit understood by the ATM network into a DS0 understood by circuit switch 370. (*Id.* at 12:26-28.) At the same time, as shown below, the CCP signals circuit switch 370 (via STP 345) to inform it that the path for the call will be extended to it and on which port the call will arrive. (*Id.* at 12:28-29.)

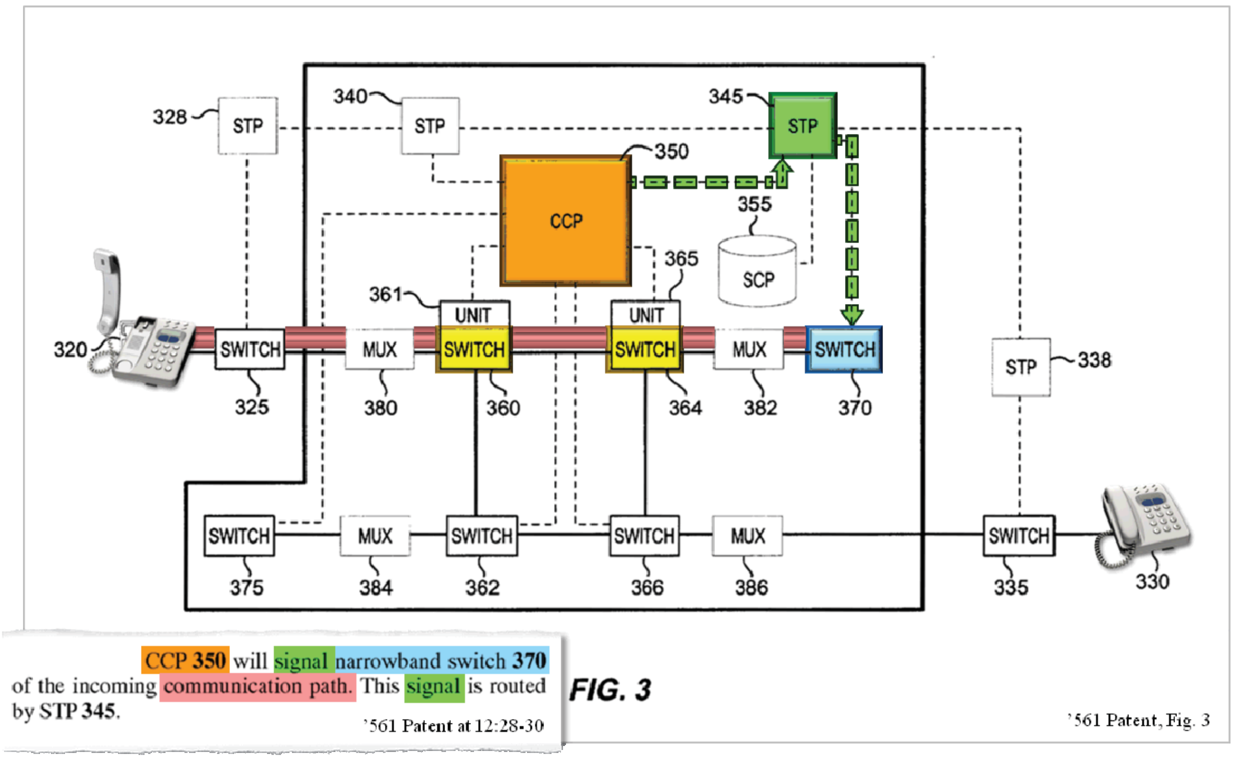
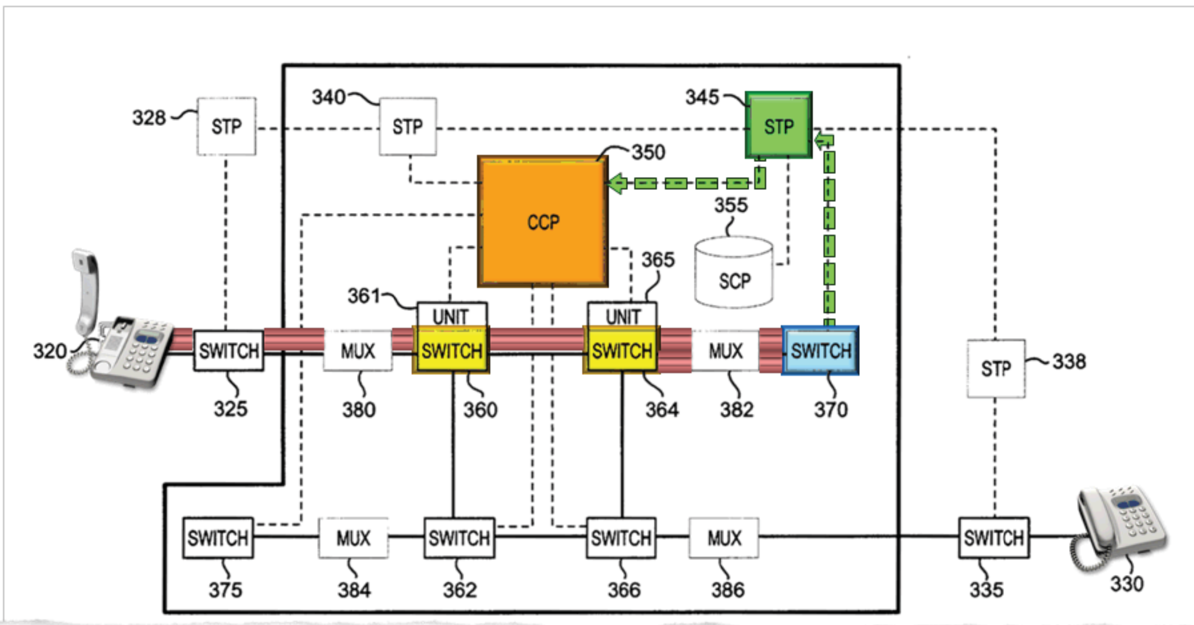


FIG. 3

'561 Patent, Fig. 3

88. Now that the end-to-end path formation has reached circuit switch 370, that switch can do billing for the call and may perform 800-number translation if needed by querying SCP 355. (*Id.* at 12:30-35.) Switch 370 will then make its own decision on how to further the path for the call, as in the PSTN, but that decision will always involve sending the call back to mux 382 and broadband (ATM) switch 364 in this example as shown below. (*Id.* at 12:35-40.)

Indeed, there is no other path leading from switch 370 in Figure 3; from the perspective of switch 370, however, it is furthering the call to another circuit switch. Switch 370 also sends signaling to be used by other circuit switches (as I described with respect to the PSTN, above), but, again, that signaling is intercepted by the CCP as shown below. (*Id.* at 12:35-38.) The CCP will then decide how to further the path of the call on the return trip back through mux 382 and onto the next switch. As before, the CCP may use information from the SCP or other sources to make such decisions. (*Id.* at 12:40-46.)



As a result of the processing, narrowband switch **370** will switch the call and generate a new signal which may include routing information. The signal is sent to **CCP 350** through STP **345**.

'561 Patent at 12:35-38

FIG. 3

The communication path is furthered on a new connection back to broadband switch **364** through mux **382**.

'561 Patent at 12:38-40

89. The CCP now selects the local (LEC) switch to which the call path should be extended. This local exchange switch 335 (on the lower right), which serves the called party, is where the call will go once it "egresses" from the long distance network.[44] The CCP selects and

[44] Because, as I explained previously, the user communications can only traverse over an established end-to-end path in a circuit or virtual circuit network such as in the Group 1 Patents,

sends a "destination code" to broadband (ATM) switch 364, which identifies broadband (ATM) switch 366 as the network element which allows egress from the network. By identifying either of the network elements which are connected to the LEC switch, the CCP also identifies LEC switch 335 and selects the port on switch 335 to which the path should be extended. (*Id.* at 12:47-60, 18:21-24.)[45] Alternatively, the CCP can select as the destination code the network code of the LEC switch itself. ('3,561, 18:15-25.) Either way, the CCP is selecting a logical address of a switch to permit egress from the long distance exchange to the local exchange. In other words, either the CCP is selecting the "terminating switch" in the long distance carrier which corresponds (on a one-to-one basis) with the external LEC switch or it selects the "LEC switch [itself] to which the communication path should be extended." (*Id.*) Egress from a long distance (IXC) network to a LEC switch is the only example of identifying a code for egressing from a network that is disclosed in the Group 1 Patents.

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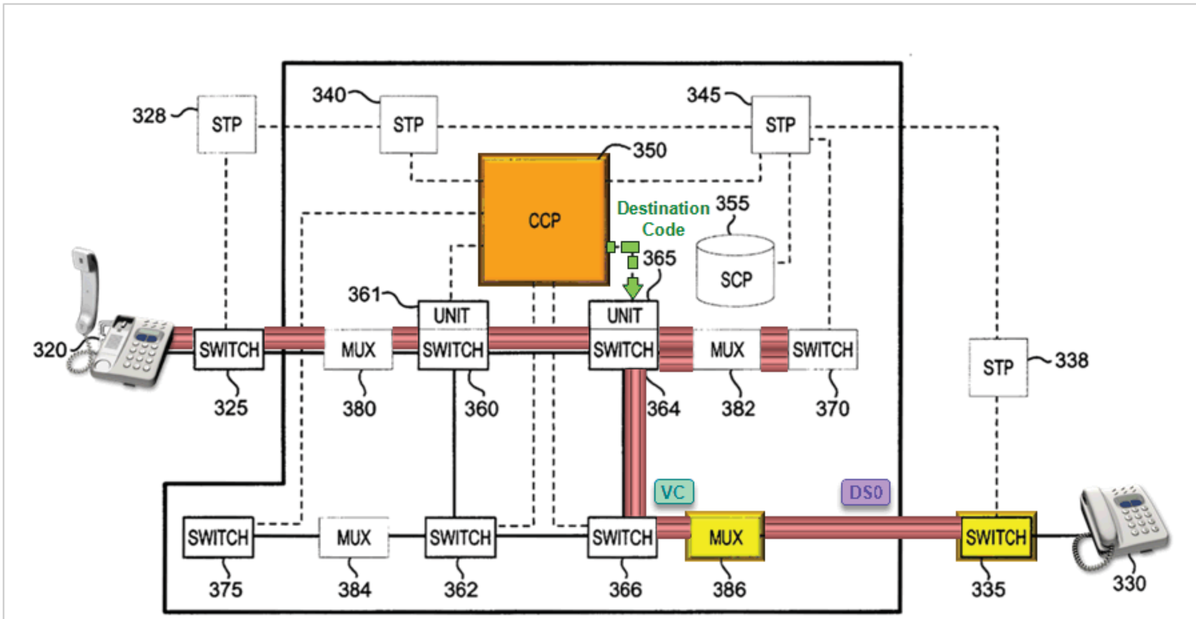
the user communications can only egress the long distance network depicted in Figure 3 over a device that is in the established communication path.

[45] The Group 1 Patents explain that a "destination code" is a form of a "network code." ('3,561 Pat. 12:47-53.) The CCP selects this to establish an end-to-end path exiting from the long distance carrier which will be used to carry user communications after the entire path is established.



The commu-nication path would be furthered to the specified port on LEC switch 335.

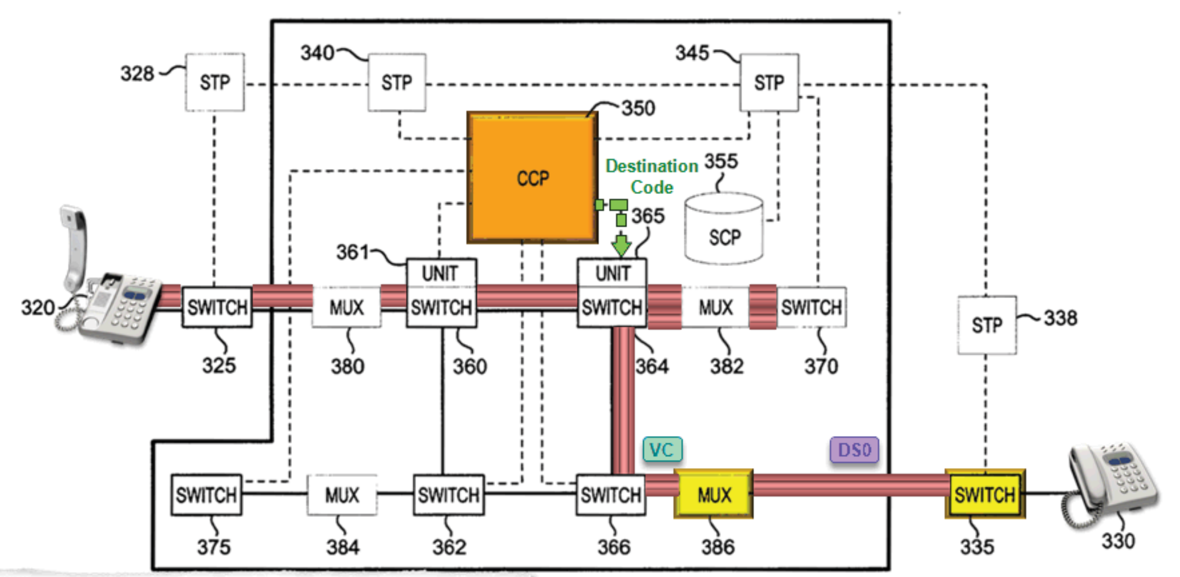
'561 Patent at 12:57-59

FIG. 3

'561 Patent, Fig. 3

90. The CCP then signals LEC switch 335 so that it knows the particular DS0 it is going to receive will correspond to this particular call. ('3,561, 12:65-13:2.) In this way, the end-to-end path is established between calling party 320 (connected to local switch 325) and called party 330 (connected to local switch 335), as illustrated below. As explained, the path was established by the CCP specifically in response to caller 320 trying to make a call. After the path is established, as in the PSTN, the parties can speak to each other, although the Group 1 patent does not discuss user communication after the path is established because it is focused entirely on setting up the end-to-end path. The inclusion of circuit switch 370 in the end-to-end path of the call permits the network to time the duration of the call for billing purposes by using the narrowband's billing capability which the Group 1 Patents explain the broadband switches lack. Presumably the patent is talking only about billing for the "long distance" portion of the

call as a billing record would routinely be kept in narrowband switch 325, although the patent is unclear about this point.



The communication path would be furthered to the specified port on LEC switch 335.

'561 Patent at 12:57-59

FIG. 3

'561 Patent, Fig. 3

B. Group 2 Patents

91. The Group 2 Patents are directed to another way of including virtual circuits and TDM circuits in the end-to-end path established on a call-by-call basis. (*See, e.g.*, '429 Pat. Abstract ("The invention is a system for providing virtual connections through an ATM interworking multiplexer on a call-by-call basis.")). The Group 2 Patents state that ATM switches[46] which are capable of participating in the establishment of an end-to-end path for telephone calls would need to be very sophisticated, and this level of sophistication was not yet mature and would be expensive. (*See id.* at 1:50-60.) The patents propose an alternative, presumably less complex and less costly way of including virtual circuits and TDM circuits in

[46] The Group 2 Patents focus exclusively on one type of broadband switch—ATM. *See, e.g.* '429 Pat. 1:20-2:67.

105. I have been asked if the term "routing system" has a known meaning in the telecommunications field. This term has no particular meaning without a specified context. The claim does not supply any context because, if anything, the "routing system" corresponds to an ATM Cross-Connect System.

106. The Northern Telecom DMS-250 referenced in the Group 1 Patents ('3,561 Pat. 10:16) was a well-known circuit element at the time of the patents' filing date.

I declare under penalty of perjury that the foregoing is true and correct.

Dated: April 4, 2014
Holmdel, New Jersey

Leonard J. Forys, Ph.D.

EXHIBIT 30

Case 2:08-cv-02046-JWL-JPO Document 120-2 Filed 09/09/2009 Page 1 of 303

EXHIBIT 1A
(303 Pages)

U.S. Patent 5,825,780
(‘605 Application)
Complete File History – Part 1 of 2

Relationship: Parent/Grandparent of Asserted ‘052, ‘561, ‘932
Immediate Parent: None
Application Number: 08/238,605 (later 08/568,551)
Filing Date: May 5, 1994
Issue Date: October 20, 1998

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appropriate selections. CCP 250 would signal network 210 and video servers 266 of its selections. As a result, a communications path would be set-up from user 220 to video servers 266.

Additionally, CCP 250 would control communications to the other network which is represented by networks 260. Networks 260 could be any other form of telecommunications network -- either public or private. CCP 250 would make the appropriate selections to further the communications path over connection 212 and network 210 to networks 260. Upon signaling from CCP 250, the connections comprising the communications path would be made. Networks 260 would also be signalled by CCP 250 over link 256. As such a communication path is set up from user 230 to video servers 266 and on to networks 260.

There may also be several devices represented by particular network element shown on Figure 2. CCP 250 could also select the particular device to access. For example, take the situation in which voice servers 268 represents 20 individual voice server devices split among three different locations. On each call, CCP 250 could select the actual voice server device which should be used on that call and control the communications through network 210 and connection 212 to the selected device. Alternatively, CCP 250 may only be required to select group of devices, for instance at a particular location, instead of the actual device.

As is known, large telecommunication networks are comprised of numerous network elements, connections, and links. The present invention is suitable for use in this context. Figure 3 shows a version of the present invention in the context of a large network. Typically, this network would be comprised of several broadband switches, narrowband switches, muxes, signal transfer points (STPs), Service Control Points (SCPs), operator centers, video

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servers, voice servers, adjunct processors, enhanced services platforms, connections, and links. For purposes of clarity, only a few of these possibilities are shown on Figure 3. For the same reason, connections and links are not numbered.

Figure 3 shows Telecommunications Network 310 which is comprised of STP 340, STP 345, CCP 350, SCP 355, broadband switches 360, 362, 364, and 366, interworking units 361 and 365, narrowband switches 370 and 375, and muxes 380, 382, 384, and 386. Aside from CCP 350, these elements of a large network are familiar to one skilled in the art and examples of the of these network elements are as follows: STP -- DSC Communications Megahub; SCP -- Tandem CLX; broadband switch -- Fore Systems ASX-100; narrowband switch -- Northern Telecom DMS-250; and mux -- Digital Link PremisWay with CBR module.

In at least one embodiment, the broadband switches are equipped with signaling interworking units. These units translate SS7 messages into B-ISDN messages. In that event, the CCP could transmit SS7 to the broadband switches which could convert the signals properly. Interworking is discussed in ITU-TS Recommendation Q.2660, "B-ISDN, B-ISUP to N-ISUP Interworking".

When user information passes from a broadband network to a narrowband network, it typically must pass through a mux. Muxes can convert transmitted information back and forth between narrowband and broadband formats. In at least one embodiment, each broadband connection on one side of a mux corresponds to a narrowband connection on the other side of the mux. In this way, the CCP can track connections through the mux. If the communication path is on a given narrowband connection entering the mux, it will exit the mux on its corresponding broadband connection. This correspondence allows the CCP to identify connections on each side of the mux based on the entry connection.

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Muxes are typically placed at any interface between narrowband and broadband connections.

As long as the connections correspond through the mux, the CCP can track the communication path properly. Alternatively, the connections may not correspond. In that case, signaling links between the muxes and the CCP would be required for the devices to communicate and allow the CCP to track the communication path.

Additionally, Telecommunications Network 310 includes the connections and links which are not numbered. These connections and links are familiar to those skilled in the art. Some examples of possible connections are switched digital lines, satellite links, microwave links, cellular links, and dedicated digital lines, but there are others. The signaling links are typically data links, such as 56 kilobit lines. The signaling may employ SS7, Broadband, C6, C7, CCIS, Q.933, Q.931, T1.607, Q.2931, B-ISUP or other forms of signaling technology. The present invention is fully operational with the many variations which are well known in the art. Additionally, it is also known that a direct link between two devices can be used instead of an STP for signal routing.

Outside of Telecommunications Network 310 are first point 320, second point 330, LEC switch 325, LEC switch 335, LEC STP 328, and LEC STP 338. These devices are shown along with their links and connections. First point 320 is connected to LEC switch 325. LEC switch 325 is linked to LEC STP 328 which routes signaling from LEC switch 325. LEC switch 325 is also connected to mux 380 of Telecommunications Network 310. LEC STP 228 is linked to STP 340 of Telecommunications Network 310.

STP 340 is linked to STP 345. The other links are as follows. STPs 340 and 345 are linked to CCP 350. CCP 350 is linked to interworking units 361 and 365 of broadband switches 360 and 364 respectively. CCP 350 is linked to

90

EXHIBIT 31

US006633561B2

(12) **United States Patent**
Christie

(10) **Patent No.: US 6,633,561 B2**
(45) **Date of Patent: *Oct. 14, 2003**

(54) **METHOD, SYSTEM AND APPARATUS FOR TELECOMMUNICATIONS CONTROL**

(75) Inventor: **Joseph Michael Christie**, San Bruno, CA (US)

(73) Assignee: **Sprint Communications Company, L.P.**, Overland Park, KS (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **10/002,850**

(22) Filed: **Nov. 14, 2001**

(65) **Prior Publication Data**

US 2002/0039372 A1 Apr. 4, 2002

Related U.S. Application Data

(63) Continuation of application No. 09/082,040, filed on May 20, 1998, which is a continuation of application No. 08/568,551, filed on Dec. 7, 1995, now Pat. No. 5,825,780, which is a continuation of application No. 08/238,605, filed on May 5, 1994, now abandoned.

(51) **Int. Cl.**[7] **H04L 12/66**

(52) **U.S. Cl.** **370/352**; 370/356; 370/410; 370/522; 379/230

(58) **Field of Search** 370/352–356, 370/401, 410, 389, 422, 426, 351, 360, 522; 379/221.08, 221.09, 221.12, 221.14, 228, 229, 230, 221.1, 219

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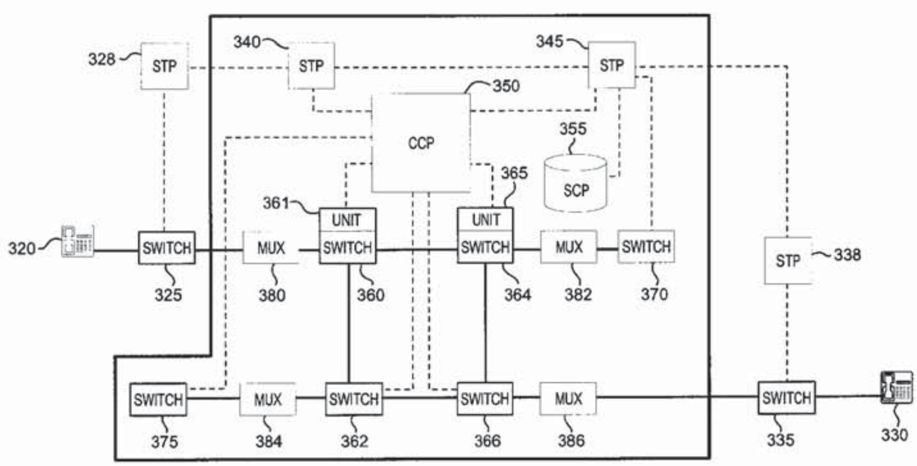
Primary Examiner—Ajit Patel

(57) **ABSTRACT**

The present invention includes a method, system, and apparatus for providing communication control. The invention includes a method in which signaling is processed externally to a switch before it is applied by the network elements. The processor is able to select network characteristics and signal the network elements based the selections. A network employing the processing method is also included, as well as a signaling system that employs the processing method.

38 Claims, 8 Drawing Sheets



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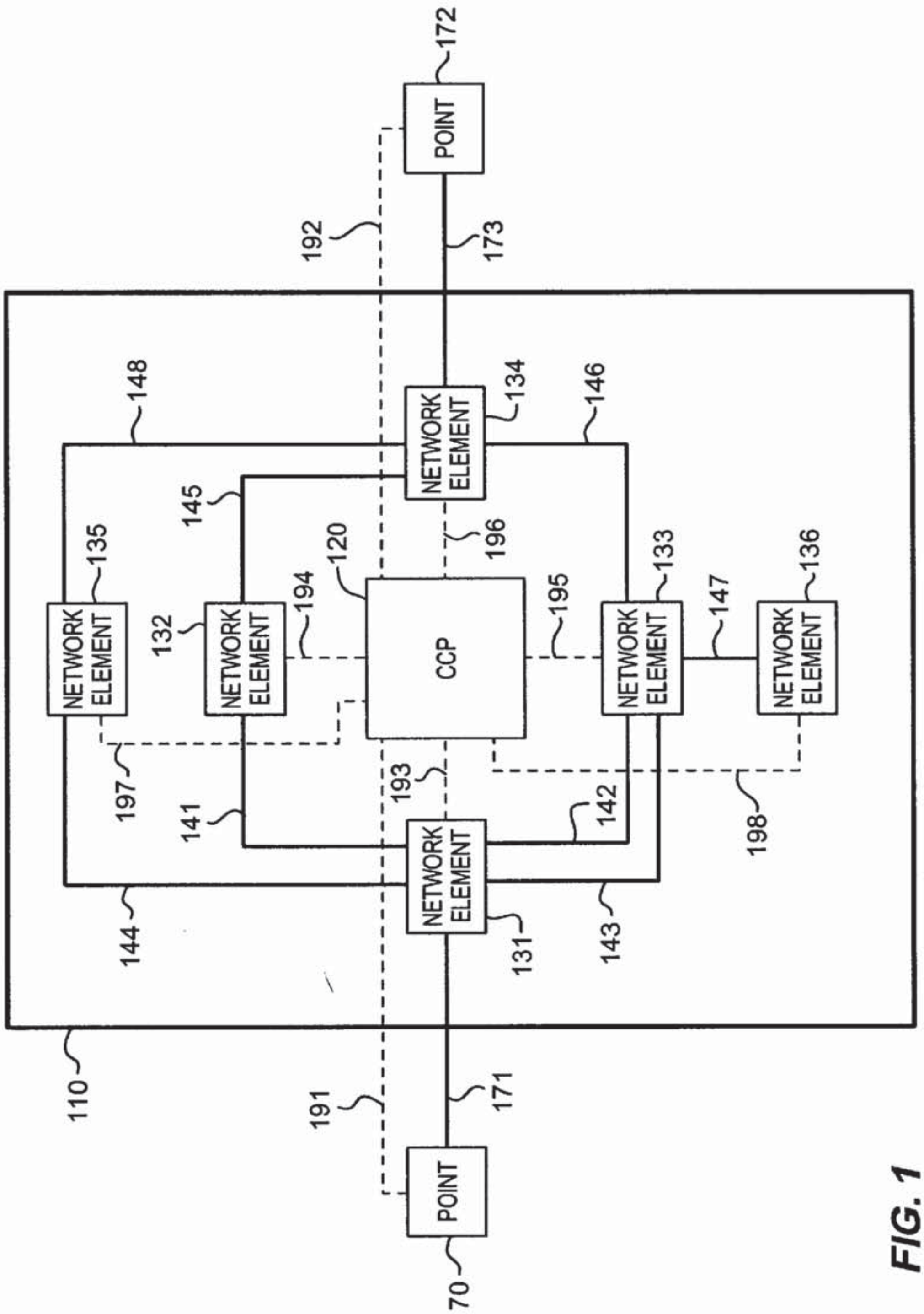

POINT
172
192
173
148
146
134
NETWORK ELEMENT
145
120
196
135
NETWORK ELEMENT
132
NETWORK ELEMENT
194
CCP
195
133
NETWORK ELEMENT
147
136
NETWORK ELEMENT
197
193
198
141
142
NETWORK ELEMENT
144
131
143
110
191
171
POINT
170

FIG. 1

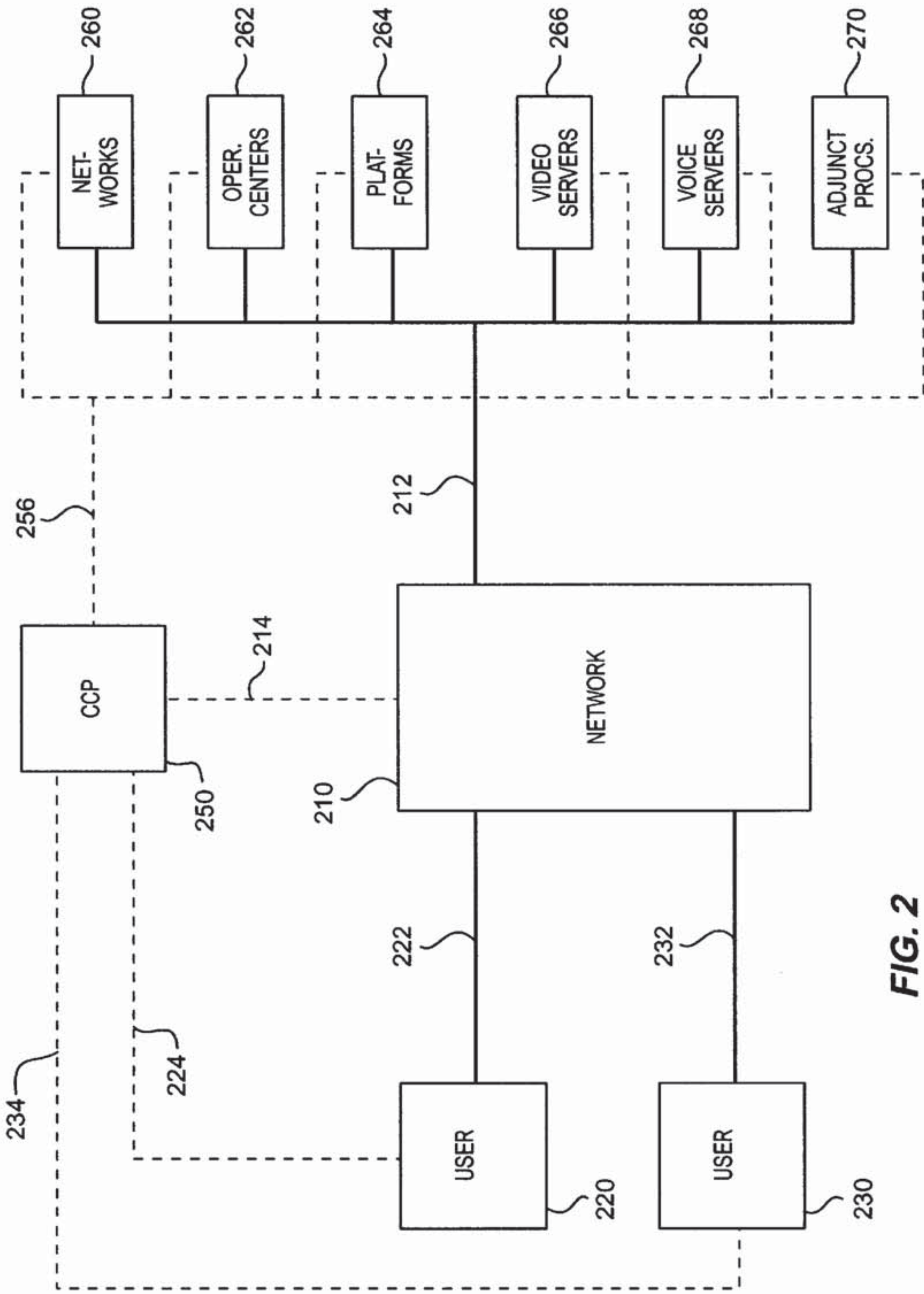

NET-WORKS
260
OPER. CENTERS
262
PLAT-FORMS
264
VIDEO SERVERS
266
VOICE SERVERS
268
ADJUNCT PROCS.
270
256
212
CCP
214
250
NETWORK
210
222
232
224
234
USER
220
USER
230

FIG. 2

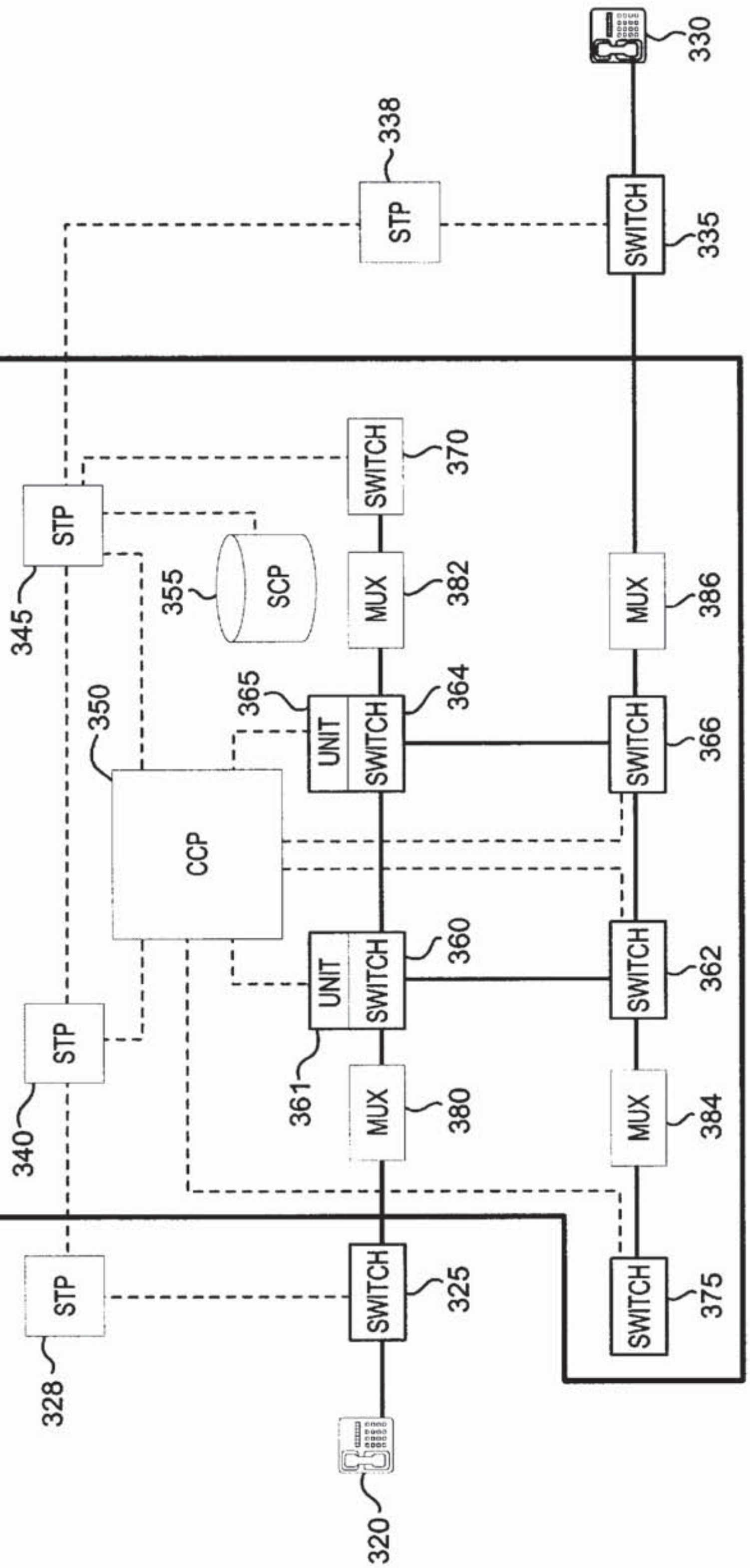

330
338
STP
SWITCH
335
STP
345
SWITCH
370
SCP
355
MUX
382
MUX
386
350
365
UNIT
SWITCH
364
SWITCH
366
CCP
UNIT
SWITCH
360
SWITCH
362
STP
340
361
MUX
380
MUX
384
STP
328
SWITCH
325
SWITCH
375
320

FIG. 3

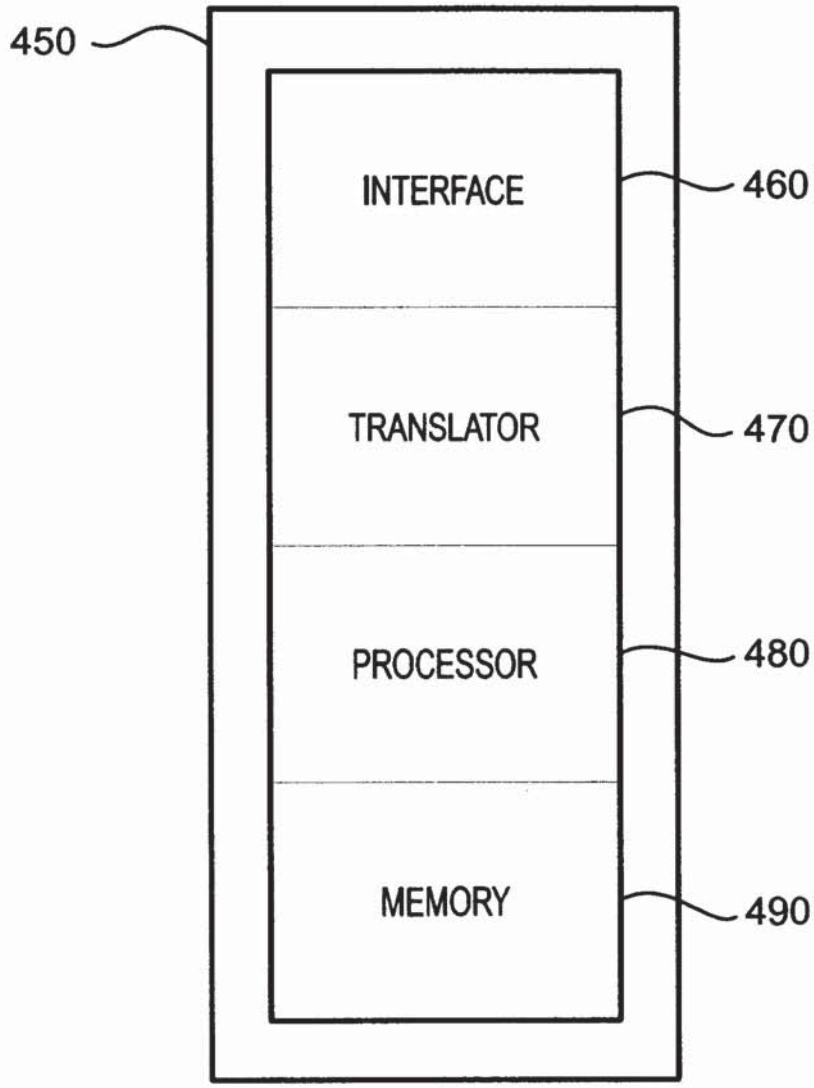


FIG. 4

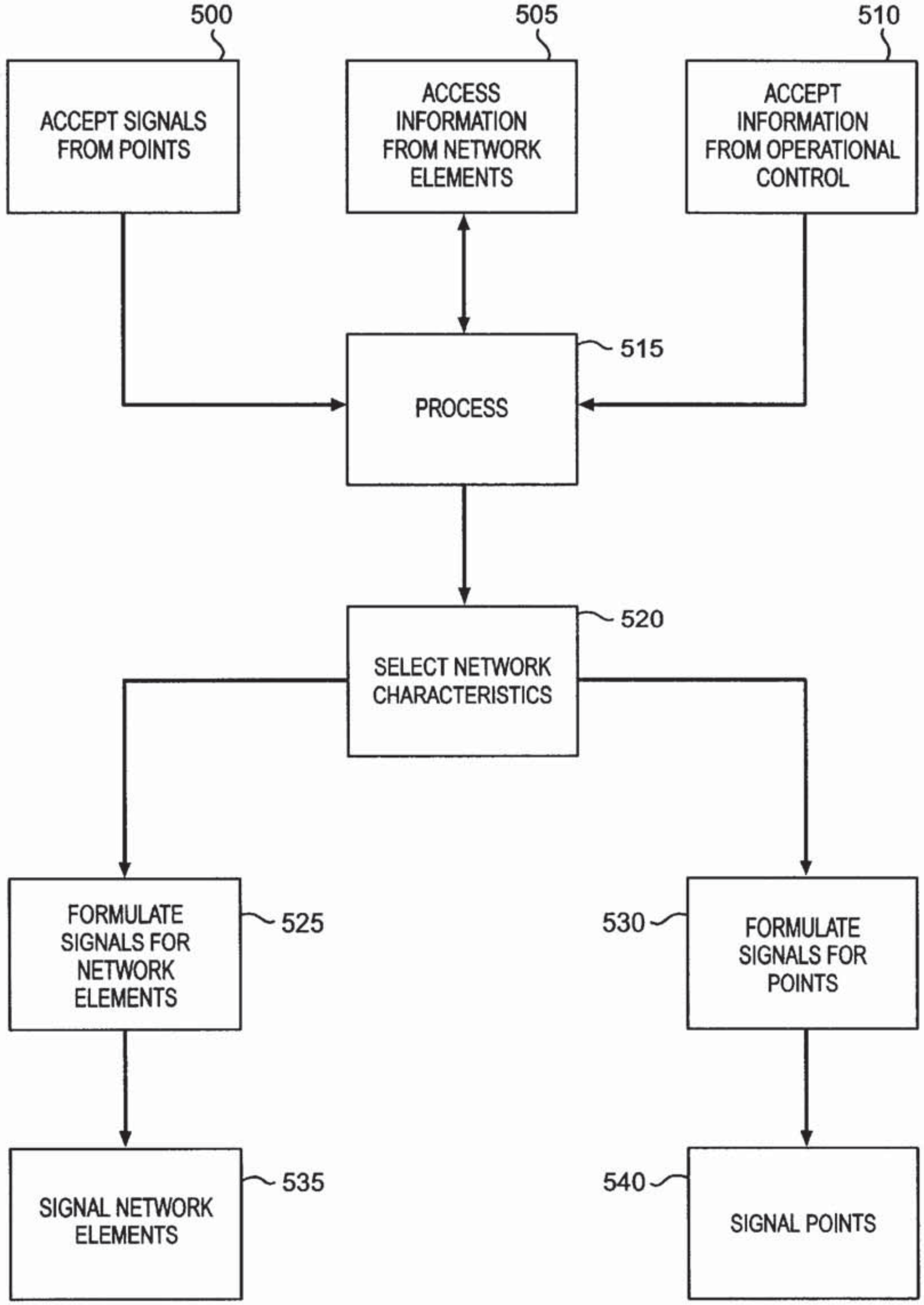
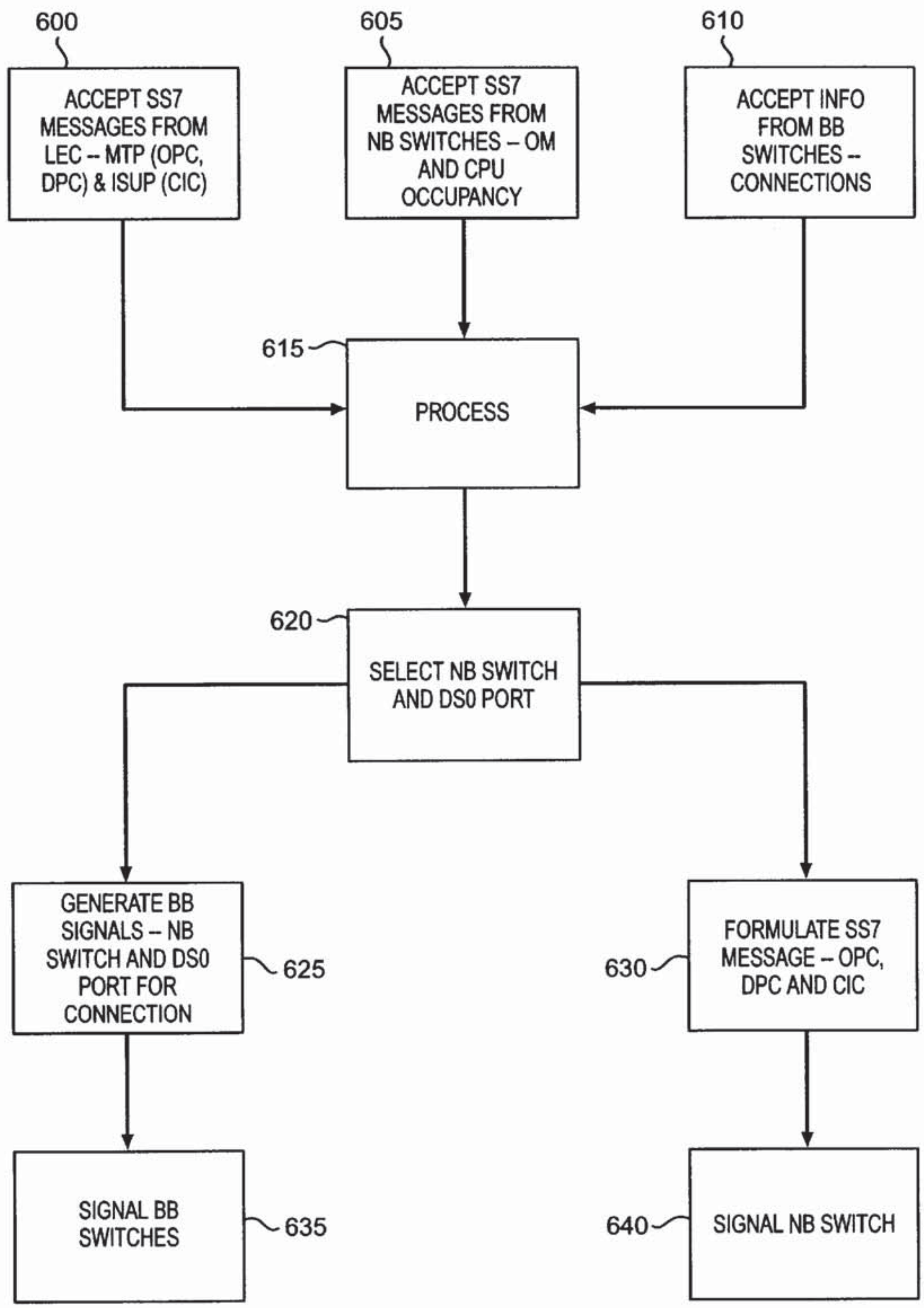

500
ACCEPT SIGNALS FROM POINTS
505
ACCESS INFORMATION FROM NETWORK ELEMENTS
510
ACCEPT INFORMATION FROM OPERATIONAL CONTROL
515
PROCESS
520
SELECT NETWORK CHARACTERISTICS
525
FORMULATE SIGNALS FOR NETWORK ELEMENTS
530
FORMULATE SIGNALS FOR POINTS
535
SIGNAL NETWORK ELEMENTS
540
SIGNAL POINTS

FIG. 5



600
ACCEPT SS7 MESSAGES FROM LEC -- MTP (OPC, DPC) & ISUP (CIC)
605
ACCEPT SS7 MESSAGES FROM NB SWITCHES -- OM AND CPU OCCUPANCY
610
ACCEPT INFO FROM BB SWITCHES -- CONNECTIONS
615
PROCESS
620
SELECT NB SWITCH AND DS0 PORT
GENERATE BB SIGNALS -- NB SWITCH AND DS0 PORT FOR CONNECTION
625
630
FORMULATE SS7 MESSAGE -- OPC, DPC AND CIC
SIGNAL BB SWITCHES
635
640
SIGNAL NB SWITCH

FIG. 6

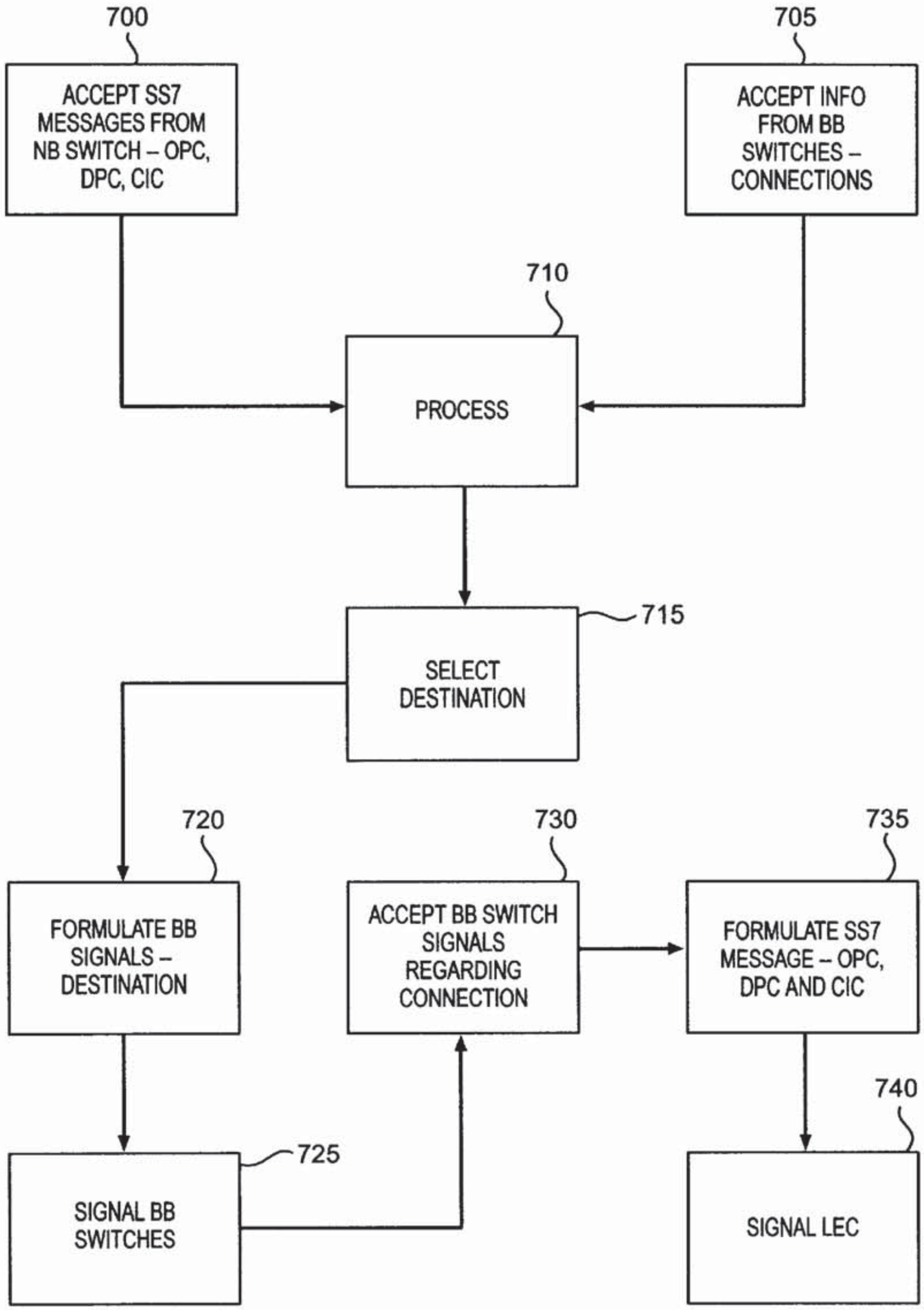
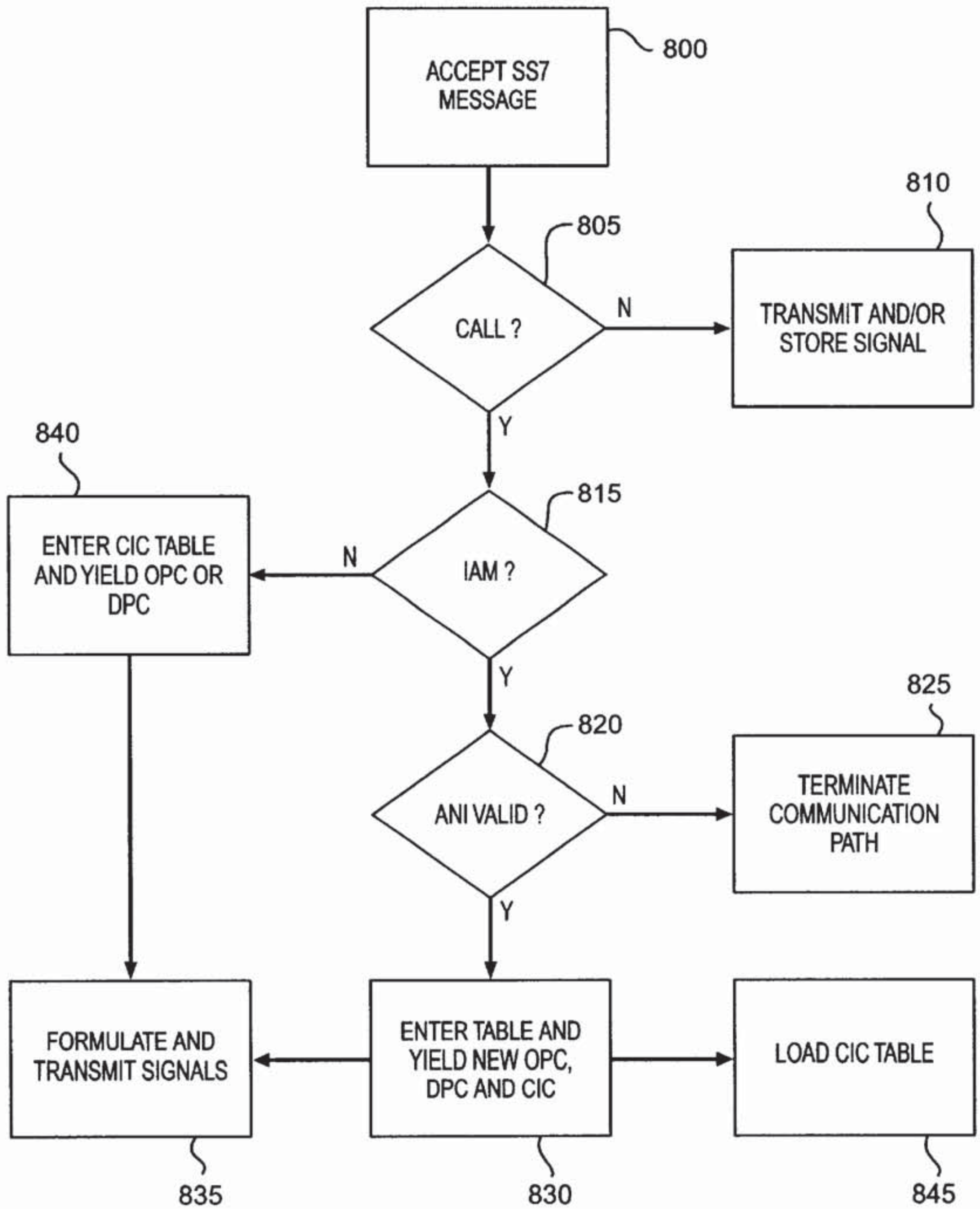

700
ACCEPT SS7 MESSAGES FROM NB SWITCH – OPC, DPC, CIC
705
ACCEPT INFO FROM BB SWITCHES – CONNECTIONS
710
PROCESS
715
SELECT DESTINATION
720
FORMULATE BB SIGNALS – DESTINATION
730
ACCEPT BB SWITCH SIGNALS REGARDING CONNECTION
735
FORMULATE SS7 MESSAGE – OPC, DPC AND CIC
725
SIGNAL BB SWITCHES
740
SIGNAL LEC

FIG. 7



ACCEPT SS7 MESSAGE
800
805
CALL ?
N
Y
TRANSMIT AND/OR STORE SIGNAL
810
840
ENTER CIC TABLE AND YIELD OPC OR DPC
815
IAM ?
N
Y
820
ANI VALID ?
N
Y
TERMINATE COMMUNICATION PATH
825
FORMULATE AND TRANSMIT SIGNALS
835
ENTER TABLE AND YIELD NEW OPC, DPC AND CIC
830
LOAD CIC TABLE
845

FIG. 8

METHOD, SYSTEM AND APPARATUS FOR TELECOMMUNICATIONS CONTROL

RELATED APPLICATIONS

This application is a continuation of application Ser. No. 09/082,040, filed on May 20, 1998, which is a continuation of application Ser. No. 08/568,551, filed on Dec. 7, 1995, now U.S. Pat. No. 5,825,780 which is a continuation of U.S. patent application Ser. No. 08/238,605, filed on May 5, 1994 and now abandoned. U.S. patent application Ser. Nos. 09/082,040, 08/568,551, 08/238,605 and 08/568,551 are hereby incorporated by reference into this application.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable

MICROFICHE APPENDIX

Not Applicable

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to telecommunications and more specifically to communications control processing in telecommunications signaling.

2. Description of the Prior Art

Telecommunications systems establish a communications path between two or more points to allow the transfer of information between the points. The communications path typically comprises a series of connections between network elements. The network elements are typically switches. Switches provide the primary means where different connections are associated to form the communications path. Communication control is the process of setting up a communications path between the points. Communication control comprises the selection of network elements such as switches or other devices which will form part of the communications path. Communication control also comprises the selection of the connections between the network elements. Together, control also comprises the selection of the connections between the network elements. Together, the network elements and connections which are selected make up the communications path. Typically, a plurality of different network element and connection selections may be possible for any one communications path between points.

Switches control these selections. Switches select the connections that comprise the communications path. Switches also select the network elements which form an actual part of that communications path. By selecting these network elements, a switch is often selecting the next switch that will make further selections. Switches accomplish communication control.

The correspondence between communication control and a communications path is well known in the art. A common method used in communication control is signaling among switches. One method by which a first point requests a communications path to a second point is by signaling a first switch with an off-hook signal followed by dual tone multifrequency (DTMF) signals. The first switch will typically process those signals and will select other network elements such as a second switch. The first switch signals the second switch and establishes a connection between the switches. The second switch then selects the next network element, signals that network element, and establishes a connection to

that network element. This process is well known in the art. The connections and signaling thus proceed from switch to switch through the network until a communications path is established between the first and second points.

Some networks transmit signaling information from the switches to other signaling devices. In these cases, the switches typically must be modified through the use of Signaling Point (SP) hardware and software in order to convert the language of the switch into the language used by these other signaling devices. One signaling device is a Service Control Point (SCP). An SCP processes signaling queries from a switch. An SCP only answers a switch query after the switch has become a part of the communications path. SCPs support the communication control which is directed by the switch.

Additionally, signaling may pass through other signaling devices, such as Signal Transfer Points (STPs), which route the signaling. An STP is typically a high-speed packet data switch which reads portions of the signaling information and either discards or routes the information to a network element. The signal routing operation of the STP is based on the signaling information that is specified by the switch. STPs route signaling information, but STPs do not modify or otherwise process the signaling information. An example of the above described system is Signaling System #7 (SS7) technology. Thus, signaling devices only are used to support switches in communication control.

Broadband systems, such as Asynchronous Transfer Mode (ATM) may use extensions of existing SS7 signaling to allow ATM switches to direct communication control. However, broadband systems may also utilize different communication control methods. ATM switches may transfer ATM cells which contain signaling to other ATM switches. As with the other switch types however, ATM switches also perform the dual task of communication control and forming a part of the communications path.

Some switches use API switching which employs remote central processing units (CPUs). These switches only receive switch information from the remote CPUs and not signaling. The protocols used for information transfer between the switch and the remote CPU are proprietary among vendors and are incompatible between the switches of different vendors.

Some digital cross-connect (DCS) equipment employ centralized control systems. These systems, however, only provide relatively static switching fabrics and do not respond to signaling. Instead of establishing connections in response to signaling, DCS cross-connections are established in response to network configuration needs. Network elements and connections are pre-programmed into the network and are not selected in response to signaling from a point outside of the network.

At present, while communication control and the communications path are distinct from one another, both are dependent on the switch. The performance of both of these tasks by switches places limitations on a telecommunications network. One such limitation can be illustrated by one difficulty encountered in combining narrowband networks and broadband networks. Broadband networks are advantageous for data transmission because virtual permanent connections can be mapped through a network and bandwidth allocated on demand. Narrowband switches are advantageous for voice, in part, due to the many features which have been developed in conjunction with these switches. These features benefit both the user and the network through added efficiency and quality. Examples are "800" platforms, billing

systems, and routing systems. However for broadband networks, the development of these features is incomplete and does not provide the functionality of current narrowband features. Unfortunately, narrowband switches do not have the capacity, speed, and multimedia capabilities of broadband switches. The resulting combination is separate overlay networks. Typically, narrowband traffic remains within the narrowband network, and broadband traffic remains within the broadband network.

Any intelligent interface between the two networks would require that signaling information be transmitted between narrowband switches and broadband switches. At present, the ability of these switches to signal each other is limited. These switch limitations create a major obstacle in any attempt to interface the two networks. It would be advantageous if narrowband and broadband networks could interwork through an intelligent interface to establish a communications path between points. At present, the interface between narrowband and broadband networks remains a rigid access pipe between overlay systems.

The reliance on switches to both perform communication control and to form the a part of the communications path results in impediments to developing improved networks. Each time a new network element, such as a broadband switch, is introduced, a telecommunications network may be forced to delay integrating the network element into its network until standardization of signaling and interface protocols are developed for the switches. At present, there is a need for a portion of the communication control processing to be independent of the switches that form a part of the communications path.

SUMMARY

An embodiment of the present invention solves this need by providing a method, system, and apparatus for communication control processing that is located externally to the switches that make the connections. The method includes receiving a first signal into a processor which is located externally to the switches in a network comprised of network elements. The processor selects a network characteristic in response to the first signal. The processor then generates a second signal reflecting the network characteristic and transmits the second signal to at least one network element. This transmission occurs before that network element has applied the first signal. Examples of network characteristics are network elements and connections, but there are others. Examples of signaling are Signaling System #7 or broadband signaling. The processor may also employ information received from the network elements or operational control when making selections. In one embodiment, the method includes receiving the first signal into a network from a point and routing the first signal to the processor.

The present invention also includes a telecommunications processing system which comprises an interface that is external to the switches and is operational to receive and transmit signaling. The processing system also includes a translator that is coupled to the interface and is operational to identify particular information in the received signaling and to generate new signaling based on new information. The processor also includes a processor that is coupled to the translator and is operational to process the identified information from the translator in order to select at least one network characteristic. The processor provides new information to the translator reflecting the selection. The identified information is used in the processor before it is used in the particular network elements that receive the new signaling.

The present invention also includes a telecommunications network comprised of a plurality of network elements wherein at least one network element is a switch, and a plurality of connections between the network elements. The network also includes a processor located externally to the switches which is operable to receive a first signal, to select at least one network characteristic in response to the first signal, and to generate a second signal reflecting the selection. The network also includes a plurality of links between the processor and the network elements which are operable to transmit the second signal to at least one network element before that network element has applied the first signal.

The present invention also includes a telecommunications signaling system for use in conjunction with a plurality of telecommunication switches. This system comprises a plurality of signaling points and a signaling processor. The signaling processor is linked to the signaling points and resides externally to the switches. The signaling processor is operational to process signaling and to generate new signaling information based on the processing. The new signaling is transmitted over the links to multiple signaling points. In one embodiment, the new signaling information is comprised of different signaling messages and the different signaling messages are transmitted to different signaling points.

In another embodiment, a plurality of the signaling points each reside in a different switch and are directly coupled to a processor in the switch that directs a switching matrix in the switch in response to signaling processed by the signaling point. The signaling processor is operational to direct the switching matrixes of multiple switches by signaling multiple signaling points. The signaling processor is also operational to signal multiple points in response to signaling from a single source, and to signal a point in response to signaling from multiple sources.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with regard to the following description, claims, and drawings where:

FIG. **1** is a block diagram of a version of the invention.

FIG. **2** is a block diagram of a version of the invention.

FIG. **3** is a block diagram of a version of the invention.

FIG. **4** is a logic diagram of a version of the invention.

FIG. **5** is a flow diagram of a version of the invention.

FIG. **6** is a flow diagram of a version of the invention.

FIG. **7** is a flow diagram of a version of the invention.

FIG. **8** is a flow diagram of a version of the invention.

DESCRIPTION

Telecommunications systems establish communications paths between points which allow the points to transfer information, such as voice and data, over the communication paths. Typically, telecommunications systems are comprised of network elements and connections. A network element is a telecommunications device such as a switch, server, service control point, service data point, enhanced platform, intelligent peripheral, service node, adjunct processor, network element of a different network, enhanced system or other network related device, server, center or system.

A connection is the media between two network elements that allows the transfer of information. A few examples of connections are: digital T1 lines, OC-3 optical fibers, packet connections, dedicated access lines, microwave

transmission, and cellular radio. As those skilled in the art are aware, connections can be described in a range from general to specific. All of the media between two switches is a general description and might correspond to a virtual path in an ATM system or a trunk groups in a T1 system. An individual circuit between two elements is more specific and might correspond to a virtual channel in an ATM system or a DS0 circuit in a T1 system. Connections can also be described as being logical or physical. Physical connections are electrical-mechanical media. Logical connections are paths which follow physical connections, but are differentiated from one another based on format and protocol. The term "connection" includes this entire range and the meaning varies according to the context in which the term is used. The present invention could make selections encompassing the entire range of connections.

A communications path is the combination of connections and network elements that physically transfers the information between points. A communication path may be point to point, point to multi-point, or multi-point to multi-point. These points, in turn, define the ends of the communications path. Thus, a connection may also be made between a network element and a point outside the network.

Signaling is the transfer of information among points and network elements and is used to establish communications paths. An example is Signaling System #7 (SS7). Signaling is typically transmitted over links, such as 56 kilobit lines. On the block diagrams, signaling is represented by dashed lines and connections are represented by solid lines.

In FIG. **1**, Telecommunications System **110** comprises a communication control processor (CCP) **120** and first, second, third, fourth, fifth and sixth network elements, **131**, **132**, **133**, **134**, **135** and **136** respectively. First and second network elements, **131** and **132** respectively, are connected by first connection **141**. First and third network elements, **131** and **133** are connected by both second and third connections, **142** and **143** respectively. First and fifth network elements, **131** and **135** respectively, are connected by fourth connection **144**. Second and fourth network elements, **132** and **134** are connected by fifth connection **145**. The third network element **133** is connected to fourth and sixth network elements, **134** and **136** by sixth and seventh connections, **146** and **147** respectively. Fourth and fifth network elements, **134** and **135** are connected by connection **148**. A first point **170**, which is located outside of the system **110**, is connected to first element **131** by first point connection **171**, and a second point **172** which is also located outside the system **110** is connected to fourth element **134** by second point connection **173**. First and second point, **170** and **172** respectively and first, second, third, fourth, fifth and sixth elements **131**, **132**, **133**, **134**, **135**, and **136** respectively each are linked to CCP **120** by first, second, third, fourth, fifth, sixth, seventh, and eighth links, **191**, **192**, **193**, **194**, **195**, **196**, **197** and **198** respectively.

As those skilled in the art are aware, a system is typically comprised of many more network elements, links, connections and points, but the number is restricted for clarity. Points outside of the network can take many forms, such as customer premises equipment (CPE), telephones, computers, or switches of a separate network system. In addition the system **110**, may take many forms such as international gateways, satellite networks, wireless networks, local exchange carriers (LECs), interexchange carriers (IXCs), transit networks, national networks, personal communicator systems (PCS), virtual private networks, or connection oriented networks such as local area networks (LANs), metropolitan area networks (MANs), wide area networks (WANs) to name some examples.

In operation Telecommunications System **110** is able to accept information from first point **170** and second point **172** and transmit the information over the various network elements and connections which form the communications path. System **110** is also capable of exchanging signaling with first point **170** and second point **172** over the first link **191** and second link **192**.

On a standard call that establishes a communications path from first point **170** to second point **172**, first point **170** will signal Telecommunications System **110** that it requests the communications path. This signaling is directed to CCP **120** over first link **191**. CCP **120** processes the signaling and selects at least one network characteristic in response to the signaling. Network characteristics might be network elements, connections, network codes, applications, or control instructions to name a few examples. The selected network characteristic typically comprises one of a plurality of network elements and/or connections. The CCP **120** generates signaling which is preferably new signaling reflecting the selection. CCP **120** then transmits the signal to at least one of a plurality of network elements before that network element has applied the signal.

In one embodiment, CCP **120** selects the network elements and the connections that comprise the communications path. However, first point **170** will typically seize first point connection **171** contemporaneously with signaling. This initial connection could also be selected by CCP **120** from the available possibilities after the signaling by first point **170**. Assuming first point **170** has seized first point connection **171** to first element **131**, CCP **120** selects one, a plurality, or all of the remaining network elements and connections to further establish a communications path to second point **172**.

CCP **120** determines which element should be connected to first element **131**. CCP **120** could select either second element **132** or third element **133**. If third element **133** is selected, CCP **120** may also select the connection to third element **133** from among second and third connections, **142** and **143** respectively. If third connection **143** is selected, CCP **120** will signal first element **131** over third link **193** to further the communications path to third element **133** over third connection **143**.

CCP **120** may then make further selections to complete the communications path. As the possibilities have been limited for clarity. CCP **120** would make the selections and signal the elements as follows. CCP **120** would signal third element **133** over fifth link **195** to further the communications path to fourth element **134** over sixth connection **146**. CCP **120** would signal fourth element **134** over sixth link **196** to further the communications path to second point **172** over second point connection **173**. CCP **120** would also signal second point **172** over second link **192** of the communications path available through second point connection **173**. In this way, the communications path requested by first point **170** is selected by CCP **120** and signaled to the elements. Throughout this process, CCP **120** may receive status messages and signaling from the elements to support its processing. This status messaging may be transmitted and received over links, connections, or other communication means.

In another embodiment, CCP **120** may select only the network elements and not the connections. The elements would select the connections to use based on the network element selected by CCP **120**. For this embodiment, the main difference from the above example is that CCP **120** would instruct first element **131** to further the communica-

tions path to third element **133**, but first element **131** would select the actual connection used from among second and third connections, **142** and **143**, respectively. First element **131** may signal CCP **120** over third link **193** of its selection so that CCP **120** may signal third element **133** of the connection over fifth link **195**. In this embodiment, CCP **120** would specify the network elements to the elements, which in turn, would select the connections between those network elements.

There are situations in which the selection of a network element and the selection of a connection signify the same thing. On FIG. **1** for example, instructing first element **131** to use first connection **141** is synonymous with an instruction to connect to second element **132**. This is because the connection inevitably connects to the element. The selection of a connection may effectively select a network element, and the selection of a network element may effectively select a connection (or a group of specific connections) to that network element.

One skilled in the art will recognize that the selection process can be distributed among the CCP and the elements. The CCP might select all the network elements, a portion of the network elements, or none of the network elements leaving the switches to select the remainder. The CCP might select all of the connections, a portion of the connections, or none of the connections, again leaving the elements to select the remainder. The CCP may select combinations of the above options, but the CCP will always select at least one network characteristic.

In another embodiment, first point **170** may want to access a other network elements such as servers, platforms or operator centers. For example, such elements could be located at either fifth or sixth network elements **135**, and **136** respectively. CCP **120** will receive signaling from first point **170** over first link **191** indicating this request, and first point **170** will typically seize first point connection **171** to first element **131**. Again CCP **120** will select network elements. If sixth element **136** is selected, CCP **120** could select a communications path from first element **131** through either second element **132** to fourth element **134** and then to third element **133**, or through a direct connection from first element **131** to third element **133**. If CCP **120** selects the latter, it would signal first element **131** to further the communications path to third element **133**, and it would signal third element **133** to further the communications path to sixth element **136**. As discussed in the above embodiments, CCP **120** may also select the connections, or the elements may be left with that task.

As is known in the art, in-band signaling is typically used in many user to network connections, such as the local loop. This is because only one connection or link is typically provided to the user premises and thus, the signaling must be placed on the actual communications path. The initial network switch typically removes the signaling from the communications path and transfers it to an out-of-band signaling system. The current invention is fully operational in this context. Although the switch may receive the signaling initially, it will only route the signaling to the CCP for processing. Even if in-band signaling is used within the network, the switches could remove signaling from the communications path and route it to the CCP for processing in accord with the present invention.

Thus, preferably the CCP processes signaling before it is applied or processed by the switch such as to select connections or generate queries. Preferably, no or minimal changes are made to the signaling prior to the signaling being received by the CCP so that the CCP receives the signaling in the same format as a switch would receive the signaling. The CCP may also process the signaling in that format. The switches make their selections based on the CCP selections, thus the switch selections clearly occur after the CCP has processed the signaling. As such, the switch may route signaling to the CCP, but the switch does not apply the signaling. Some examples of a switch applying the signaling would be selecting network elements or generating queries for remote devices.

In one of the above embodiments, the switches did not select the network elements and connections, initiate the signaling, or otherwise control the communication. The switches only followed the instructions of the CCP and actually made the connections that furthered the communications path. In one embodiment, the switches were allowed to select the actual connections used, but even these selections were based on CCP selections.

As illustrated above, the CCP allows a telecommunications network to separate communication control from the communications path. In prior systems, the switches would select the network elements and the connections, as well as, actually providing a part of the actual connection. As a result, prior systems are restricted to the communication control capabilities provided by the switches. Prior systems have used remote devices, such as an SCP, to support switch control, but the remote device only answered queries in response to the switches processing of the signal. These remote devices do not process the signaling before the switch had already applied the signaling. By using the CCP, telecommunications systems can control communications independently of the capability of the switches to accomplish both tasks.

FIG. **2** shows a block diagram of another embodiment of the present invention. CCP **250** and network **210** are shown. CCP **250** is a communications control processor. CCP **250** could be integrated into network **210**, but need not be and is shown separately for clarity. Network **210** could be any type of telecommunications network that operates using network elements, signaling, and connections. Examples would be LECs, IXCs, LANs, MANs, WANs, and Cellular Networks, but there are others. Additionally, network **210** could be narrowband, broadband, packet-based, or a hybrid. Network **210** is capable of providing communications paths between points both inside and outside of network **210**. CCP **250** and network **210** are linked by link **214** and are able to signal each other in order to establish these paths.

Additionally, user **220**, and user **230** are shown and are also capable of signaling. Examples of users **220** and **230** might be telephones, computers, or even switches in another telecommunications network. Users **220** and **230** are connected to network **210** by connections **222** and **232** respectively. Users **220** and **230** are linked to CCP **250** by links **224** and **234** respectively. Signaling may be transmitted over links **224** and **234**. If in-band signaling is employed on connections **222** and **232**, network **210** would separate at least a portion of the signaling out-of-band and transmit it to CCP **250** over link **214**.

Also shown are various network elements. As with CCP **250**, these elements could also be integrated into network **210**, but are shown separately for clarity. These network elements are: networks **260**, operator centers **262**, enhanced platforms **264**, video servers **266**, voice servers **268**, and adjunct processors **270**. This is not an exclusive list. Those skilled in the art will recognize these network elements and their functions, as well as the many other types of telecom-

munications devices, such as billing servers, that are applicable in this situation.

Each network element is connected to network **210** by connection **212**. Connection **212** represents several actual connections between the network elements (**260–270**) and different elements in network **210**. One bus-type connection is shown for purposes of clarity, but those skilled in the art are familiar with many actual types of connections to use. Additionally link **256** is shown from CCP **250** to the network elements (**260–270**). Link **256** is similarly represented as a bus-type link for clarity, and multiple links are actually used, although some network elements may not even require links. Link **214** has been simplified for clarity in the same fashion.

In one embodiment, user **220** may desire to establish a communications path to user **230**. CCP **250** would make the appropriate selections and signal the net elements in network **210** as discussed with regard to the embodiments of FIG. **1**. As a result, a communications path would be established from user **220** to user **230** through network **210** and connections **222** and **232**.

In another embodiment, user **220** may desire to access one of the various network elements (**260–270**). User **220** will typically seize connection **222** to network **210** and generate signaling. Both in-band signaling on connection **222** and out-of-band signaling on link **224** would be directed to CCP **250**. By processing the signaling, CCP **250** can select any of the network elements (**260–270**) and control the communications through network **210** and connection **212** to the network elements (**260–270**).

For example, should user **220** desire to connect to a video server and another network, user **220** would signal the request. The signaling would be directed to CCP **250** over link **224**, or over connection **222** and link **214** as discussed above. CCP **250** would process the signaling and make the appropriate selections. CCP **250** would signal network **210** and video servers **266** of its selections. As a result, a communications path would be set-up from user **220** to video servers **266**.

Additionally, CCP **250** would control communications to the other network which is represented by networks **260**. Networks **260** could be any other form of telecommunications network-either public or private. CCP **250** would make the appropriate selections to further the communications path over connection **212** and network **210** to networks **260**. Upon signaling from CCP **250**, the connections comprising the communications path would be made. Networks **260** would also be signalled by CCP **250** over link **256**. As such a communication path is set up from user **230** to video servers **266** and on to networks **260**.

There may also be several devices represented by particular network element shown on FIG. **2**. CCP **250** could also select the particular device to access. For example, take the situation in which voice servers **268** represents 20 individual voice server devices split among three different locations. On each call, CCP **250** could select the actual voice server device which should be used on that call and control the communications through network **210** and connection **212** to the selected device. Alternatively, CCP **250** may only be required to select group of devices, for instance at a particular location, instead of the actual device.

As is known, large telecommunication networks are comprised of numerous network elements, connections, and links. The present invention is suitable for use in this context. FIG. **3** shows a version of the present invention in the context of a large network. Typically, this network would be comprised of several broadband switches, narrowband switches, muxes, signal transfer points (STPs), Service Control Points (SCPs), operator centers, video servers, voice servers, adjunct processors, enhanced services platforms, connections, and links. For purposes of clarity, only a few of these possibilities are shown on FIG. **3**. For the same reason, connections and links are not numbered.

FIG. **3** shows Telecommunications Network **310** which is comprised of STP **340**, STP **345**, CCP **350**, SCP **355**, broadband switches **360**, **362**, **364**, and **366**, interworking units **361** and **365**, narrowband switches **370** and **375**, and muxes **380**, **382**, **384**, and **386**. Aside from CCP **350**, these elements of a large network are familiar to one skilled in the art and examples of the of these network elements are as follows: STP—DSC Communications Megahub; SCP—Tandem CLX; broadband switch—Fore Systems ASX-**100**; narrowband switch—Northern Telecom DMS-**250**; and mux—Digital Link PremisWay with CBR module.

In at least one embodiment, the broadband switches are equipped with signaling interworking units. These units translate SS7 messages into B-ISDN messages. In that event, the CCP could transmit SS7 to the broadband switches which could convert the signals properly. Interworking is discussed in ITU-TS Recommendation Q.2660, "B-ISDN, B-ISUP to N-ISUP Interworking".

When user information passes from a broadband network to a narrowband network, it typically must pass through a mux. Muxes can convert transmitted information back and forth between narrowband and broadband formats. In at least one embodiment, each broadband connection on one side of a mux corresponds to a narrowband connection on the other side of the mux. In this way, the CCP can track connections through the mux. If the communication path is on a given narrowband connection entering the mux, it will exit the mux on its corresponding broadband connection. This correspondence allows the CCP to identify connections on each side of the mux based on the entry connection. Muxes are typically placed at any interface between narrowband and broadband connections.

As long as the connections correspond through the mux, the CCP can track the communication path properly. Alternatively, the connections may not correspond. In that case, signaling links between the muxes and the CCP would be required for the devices to communicate and allow the CCP to track the communication path.

Additionally, Telecommunications Network **310** includes the connections and links which are not numbered. These connections and links are familiar to those skilled in the art. Some examples of possible connections are switched digital lines, satellite links, microwave links, cellular links, and dedicated digital lines, but there are others. The signaling links are typically data links, such as 56 kilobit lines. The signaling may employ SS7,Broadband, C6, C7, CCIS, Q.933, Q.931, T1.607, Q.2931, B-ISUP or other forms of signaling technology. The present invention is fully operational with the many variations which are well known in the art. Additionally, it is also known that a direct link between two devices can be used instead of an STP for signal routing.

Outside of Telecommunications Network **310** are first point **320**, second point **330**, LEC switch **325**, LEC switch **335**, LEC STP **328**, and LEC STP **338**. These devices are shown along with their links and connections. First point **320** is connected to LEC switch **325**. LEC switch **325** is linked to LEC STP **328** which routes signaling from LEC switch **325**. LEC switch **325** is also connected to mux **380** of Telecommunications Network **310**. LEC STP **228** is linked to STP **340** of Telecommunications Network **310**.

STP **340** is linked to STP **345**. The other links are as follows. STPs **340** and **345** are linked to CCP **350**. CCP **350** is linked to interworking units **361** and **365** of broadband switches **360** and **364** respectively. CCP **350** is linked to broadband switches **362** and **366**, and narrowband switch **375**. STP **345** is linked to narrowband switch **370** and SCP **355**. STP **345** is also linked to LEC STP **338** which is linked to LEC switch **335**.

Mux **380** is connected to broadband switch **360**. Broadband switch **360** is connected to broadband switches **362** and **364**. Broadband switch **362** is connected to mux **384** which is connected to narrowband switch **375**. Broadband switch **364** is connected to mux **382** which is connected to narrowband switch **370**. Broadband switches **362** and **364** are both connected to broadband switch **366**. Broadband switch **366** is connected to mux **386** which is connected to LEC switch **335**. LEC switch **335** is connected to second point **330**.

When a call is placed from first point **320** that requires the use of Telecommunications Network **310**, LEC switch **325** will typically seize a connection to Telecommunications Network **310** and generate a signal containing call information. At present, this signal is in SS7 format and the seized connection is a DS0 port. The signal is transmitted to LEC STP **328** which transfers it on to STP **340**. LEC switch **325** also extends the communication path over the seized connection. These LEC components and the process of establishing communication paths between a point, a LEC, and an IXC are familiar to those skilled in the art.

Telecommunications Network **310** accepts the communication path on the narrowband side of mux **380**. The present invention can also accept broadband calls that do not require a mux, but typically, calls from a LEC will be narrowband. Mux **380** converts the call to broadband and places it on the broadband connection that corresponds to the seized connection. The communication path extends to broadband switch **360** through mux **380**.

STP **340** transfers the signal from LEC STP **328** to STP **345** which, in turn, routes the signal to CCP **350**. Also, CCP **350** accepts status messages from the broadband and narrowband switches over standard communications lines, and may query SCP **355** for information. Any suitable database or processor could be used to support CCP **350** queries. CCP **350** uses this information and its own programmed instructions to make communication control selections. For calls that require narrowband switch treatment, CCP **350** will select the narrowband switch.

Preferably, CCP **350** can select any narrowband switch in Telecommunications Network **310**. For example, it may extend the communication path through the broadband network to a narrowband switch across the network for processing, or it may extend the communication path to a narrowband switch connected to the broadband switch that originally accepts the communication path. Additionally, no narrowband switch may be required at all. For clarity, all of the switches representing these possibilities are not shown on FIG. **3**.

CCP **350** will select at least one network characteristic in response to the signaling. Typically, this will be the network elements or connections that will make the communication path. As discussed with regard to the above embodiments, CCP **350** may select only the network elements and allow the switches to select the connections, or the selections can be distributed among the two. For example, CCP **350** may only select some of the network elements and connections and allow the switches to select some of the network elements and connections. CCP **350** might only select the narrowband switches and allow the broadband switches to select the broadband switches that will make the communication path. CCP **350** can also select other network characteristics, such as applications and control instructions.

In one embodiment, CCP **350** will select the narrowband switches to process particular calls and the DS0 ports on those switches which will accept these calls. The broadband switches will select the broadband switches and the broadband connections to the DS0 port. Restricted to the possibilities depicted on FIG. **3**, CCP **350** may select either narrowband switch **370** or narrowband switch **375** to process the call. Assuming CCP **350** selects narrowband switch **370**, it would also select a DS0 port on narrowband switch **370** to accept the connection. CCP **350** would then signal broadband switch **360** through interworking unit **361** to farther the communications path to the selected DS0 port on narrowband switch **370**.

Of the possible routes, broadband switch **360** would be left to select the other broadband switches and connections to use. Assuming the route directly to broadband switch **364** is selected, broadband switch **360** would further the communications path to that switch. Broadband switch **360** would also signal broadband switch **364** of the communication path. Broadband switch **364** would further the communication path to through mux **382** to access the specified DS0 port on narrowband switch **370**. This is accomplished by corresponding the connections through the mux as discussed above. CCP **350** will signal narrowband switch **370** of the incoming communication path. This signal is routed by STP **345**. Narrowband switch **370** will process the call on the specified DS0 port. Typically, this would include billing and routing the call. Narrowband switch **370** may also query SCP **355** to aid in application of services to the call. For example, narrowband switch **370** may retrieve an "800" translation from SCP **355**. As a result of the processing, narrowband switch **370** will switch the call and generate a new signal which may include routing information. The signal is sent to CCP **350** through STP **345**. The communication path is furthered on a new connection back to broadband switch **364** through mux **382**. CCP **350** may use the information in the signal, SCP information, network element information, operational instructions, and/or its own routing logic to make new selections for the call. The network element information and operational instructions could be signalled to CCP **350** or delivered over standard data lines.

In one embodiment, the selection of a network characteristic will include the selection of a network code. Network codes are the logical addresses of network elements. One such code is a destination code that facilitates egress from Telecommunications System **310**. The destination code typically represents a network element that is connected to a LEC switch. Once a destination is selected, CCP **350** will signal broadband switch **364** of its selections and the communication path will be furthered through the broadband network accordingly. In the current example this could be through broadband switch **366** and mux **386**. The communication path would be furthered to the specified port on LEC switch **335**. Typically, this involves the seizure of a connection on the LEC switch by the IXC.

In one embodiment, whenever broadband switch **366** extends a communication path to mux **386**, it is programmed to signal CCP **350** of the broadband connection it has selected. This allows CCP **350** to track the specific DS0 port on the LEC switch that has been seized. CCP **350** would signal LEC switch **335** through STP **345** and LEC STP **338** of the incoming call on the seized DS0 connection. As a

result, LEC switch **335** would further the communication path to second point **330**.

It can be seen from the above disclosure that the present invention allows a telecommunications network to employ a broadband network to make call connections. By using muxes to convert calls and a CCP to analyze signaling, this broadband network remains transparent to the networks of other companies. An example of such a transparent interface is between an interexchange carrier (IXC) network and a local exchange carrier (LEC) network. Similarly the network will be transparent if deployed in only a portion of a single company's network infrastructure.

In the above embodiment, the LEC seizes an IXC DS0 port and signals to an IXC STP. The mux and the CCP convert the call and analyze the signal appropriately. No changes in other existing carrier systems, such as LEC systems, are required.

Additionally the narrowband switch receives the call and signal in its own format and switches the call. Although the switch may "think" the call is routed over a trunk to another narrowband switch, the call actually goes right back to the mux and broadband switch that sent the call. The narrowband switch is used to apply features to the call, i.e. billing, routing, etc. The broadband network is used to make the substantial portion of the call connection. The CCP may use narrowband switch call processing information to make selections.

The CCP performs many functions. In one embodiment, it accepts signaling from a first point or LEC and provides appropriate signals in accord with the communication control selections it has made. These selections are network characteristics. The CCP may select network elements such as switches, servers, or network codes. The CCP may select connections, such as DS0 circuits and ports. The CCP may select particular telecommunications applications to be applied to the communications path. The CCP may select particular control instructions for particular devices. The CCP may also receive information from entities such as SCPs, operational control, or switches to aid in its selections.

The CCP is a processing system, and as such, those skilled in the art are aware that such systems can be housed in a single device or distributed among several devices. Additionally, multiple devices with overlapping capabilities might be desired for purposes of redundancy. The present invention encompasses these variations. One such operational system would be multiple pairs of CCPs located regionally within a telecommunications system. Each machine would be equally capable of communication control. One example of a CCP device would be a Tandem CLX machine configured in accord with this disclosure of the present invention.

A signaling point handles the signaling for a switch. Switches which are used to route calls typically have a signaling point which is directly coupled to a processor in the switch. This processor controls a switching matrix in the switch in response to the signaling processed by the signaling point. Thus, there is typically a one to one correspondence of a signaling point for each switch and matrix.

The CCP is not directly coupled to one switch, one switch processor (CPU), or one switching matrix. In contrast, the CCP has the capability of directing a plurality of switches. Thus, the CCP can direct multiple switch matrixes by signaling multiple signaling points.

It is possible to house the CCP within other telecommunication devices, even switches. Although the CCP can be primarily distinguished from a switch CPU based on physical location, this does not have to be the case. A switch CPU receives information from a signaling point and controls the matrix of a single switch. Some switches distribute the matrix among different physical locations, but the CPU controls each matrix based on information received from a single signaling point This information is not signaling.

In contrast, the CCP receives signaling and has the ability to signal other network elements. It can communicate with multiple signaling points. These signaling points provide information to the switch CPUs which control the switch matrixes. By signaling multiple signaling points, the CCP is able to direct the matrixes of multiple switches based on the signaling and other information the CCP obtains. A CCP is not associated with a single switch matrix. A CCP does not require communication path connections in order to operate.

The main capabilities of one version of a CCP are shown on FIG. **4**. CCP **450** comprises interface **460**, translator **470** operably connected to interface **460**, processor **480** operably connected to translator **470**, and memory **490** operably connected to processor **480**.

CCP **450** functions to physically connect incoming links from other devices such as STPs, switches, SCPs, and operational control systems. Interface **460** is functional to accept the signals off of these links and transfer the signals to translator **470**. Interface **460** is also be able to transfer signaling from translator **470** to the links for transmission.

Translator **470** accepts the signaling from interface **460** and identifies the information in the signaling. Often, this will be done by identifying a known field within a given signaling message. For example, translator **470** might identify the Origination Point Code (OPC), Destination Point Code (DPC), and Circuit Identification Code (CIC) in an SS7 message. Additionally, translator **470** must be able to formulate outgoing signaling and transmit it to interface **460** for transmission. For example, translator **470** might replace the OPC, DPC, and CIC in a given SS7 message and transfer the modified SS7 message to interface **460** for transmission. Translator **510** must be equipped to manage the signaling formats it will encounter. Examples are SS7 and C7.

Processor **480** accepts the signaling information from translator **470** and makes the selections that accomplish communication control. This includes the selection of the network elements and/or connections that make the communications path. Typically, selections are made through table look-ups and SCP queries. Tables are entered and queries are generated based in part on the information identified by translator **470**. The table look-ups and SCP information retrieval yield new signaling information. The new information is transferred to translator **470** for formulation into appropriate signals for transmission. Algorithm solution could also be used to make selections. Processor **480** also handles various, status messages and alarms from the switches and other network elements. Operational control can also be accepted. This information can be used to modify the look-up tables or selection algorithms. Memory **490** is used by processor **480** to store programming, information, and tables.

FIG. **5** shows a flow diagram for the CCP for a version of the present invention. The sequence begins with the CCP receiving different types of information. Box **500** depicts the CCP accepting a signal from a first point. This signal could be in any format, such as SS7 or broadband signaling. The signal may have passed through STPs from a LEC over a signaling link, or it may also be a signal directly provided by an individual user of a network. The signal contains information about the requested communication path. An

example of such information is the message type which indicates the purpose of the message. Another example of such information is set-up information such as transit network service value, bearer capability, nature of address, calling party category, address presentation restriction status, carrier selection value, charge number, and originating line information, and service code value. Other information might be a network indicator or a service indicator. Those skilled in the art are familiar with these types of information.

Other types of information might also be accessed by the CCP. The network elements, such as switches, may provide the CCP with information as shown inbox **505**. This information allows the CCP to select network elements and connections based on network conditions. Examples of possible types of such information could be management messages, loading, error conditions, alarms, or idle circuits. The CCP might also provide the network elements with information.

Box **510** shows that operational control might be provided. Operational control allows system personnel to program the CCP. An example of such control might be to implement a management decision to retire a particular network element. Operational control would allow the removal that element from the selection process.

The CCP processes the information is has received in box **515**. Processing also entails the use of programmed instructions in the CCP, and might even include the use of information retrieved from a remote database, such as an SCP. The selections are then made as shown in box **520**. These selections specify network characteristics, such as network elements and/or connections. As stated above, The CCP may only select a portion of the network characteristics and allow the points or the switches to select the remainder. It should be pointed out that the information used in processing is not limited to that which is listed, and those skilled in the art will recognize other useful information which may be sent to the CCP.

Once network characteristics are selected, the CCP will signal the points and the applicable network elements of the selections. In box **525**, signals are formulated instructing the network elements of the network characteristics selected. The signals are transmitted to the appropriate network elements in box **535** which will typically result in a communication path through the network elements and connections. Other activity, such as applications and control procedures might be implemented as well. Additionally, in boxes **530** and **540**, signals are formulated and sent to the points. Typically the new signals generated by the CCP are sent to network elements or multiple signaling points. These new signals could be the same, however different signaling is typically sent to the different network elements which may used as part of a communication path.

FIG. **5** represents the sequence that the CCP performs in one embodiment to control communications and establish a communication path from a first point to a second point through network elements and connections. FIGS. **6** and **7** represent a similar sequence, and they are in the context of an Interexchange Carrier (IXC) similar to that depicted in FIG. **3**. The IXC accepts DS0 connections and SS7 signaling from a LEC and employs a broadband system to make the substantial portion of the communication path.

FIG. **6** depicts the flow of the CCP in a version of the present invention when a communication path is established from the LEC to a narrowband switch in the IXC. Box **600** shows that an SS7 message is accepted from the LEC which contains a Message Transfer Part (MTP) and an Integrated Service User Part (ISUP). As those skilled in the art are aware, the MTP contains the Originating Point Code (OPC) and the Destination Point Code (DPC). These point codes define specific signaling points in the network and are typically associated with a switch. As such, the OPC and DPC define a portion of the desired communication path.

When the communication path is extended into the IXC network, the OPC designates the LEC switch that connected to the IXC (**#325** on FIG. **3**). Previously, the DPC has designated the narrowband switch that the LEC would connect to for calls into the IXC. In this embodiment of the present invention, the DPC may designate a particular narrowband switch from the LEC's perspective, but the CCP actually selects the actual narrowband switch used. A mux or a broadband switch accepts the connection from the LEC, not a narrowband switch.

The ISUP contains the Circuit Identification Code (CIC) which designates the DS0 port that the LEC has seized. Previously, this DS0 Port was on a narrowband switch, but in this embodiment of the present invention, the DS0 port is actually on a mux.

Box **605** shows that the CCP may receive status information from the narrowband switches. These messages include Operational Measurements (OM) and CPU Occupancy information. OM includes trunk usage status of the switches which tells the CCP which DS0 ports are available on the narrowband switches. CPU Occupancy tells the CCP of the specific switching load of each narrowband switch. Box **610** shows that the CCP may also accept status information from the broadband switches indicating which connections are idle. This information allows the CCP to specify and balance routing through the broadband switches if desired. As discussed in relation to some of the other embodiments, the broadband switches may be left with that selection.

The CCP processes the information it has received in box **615**. Those skilled in the art are aware of other information which would be useful in this context. As a result of the processing, a narrowband switch and a DS0 port on that switch are typically selected as shown in box **620**. The selected narrowband switch may be close to the LEC or across the broadband network. The CCP determines which narrowband switch will process the call. This makes the narrowband switches virtually interchangeable.

Box **625** shows that a signal indicating these selections is generated and sent to the appropriate broadband switches in box **635**. As discussed, the broadband switches may employ interworking units to handle signaling. Typically, the broadband switches will use internal tables to select broadband connections based on information in the signal from the CCP. Such information might identify the existing extent of the communication path and specify the narrowband switch and the DS0 port on that switch to which the communication path should be extended. The tables would be entered with this information and yield a particular broadband connection to use. Broadband switches further along the communications path could also receive similar signals from the CCP and use similar tables. Alternatively, the broadband switches further along the communications path might only need to enter an internal table using the incoming broadband connection and yield a new broadband connection on which to extend the communications path.

Those skilled in the art are familiar with broadband systems which can accomplish this. Broadband signaling is discussed in the following ITU-TS Recommendations:

Q.2762 "B-ISDN, B-ISDN User Part—General Functions of Messages"; Q.2763 "B-ISDN, B-ISDN User Part—Formats and Codes"; Q.2764 "B-ISDN, B-ISDN User Part—Basic Call Procedures"; Q.2730 "B-ISDN, B-ISDN User Part—Supplementary Services"; Q.2750 "B-ISDN, B-ISDN User Part to DSS2 Interworking Procedures"; and Q.2610 "Usage of Cause and Location in B-ISDN User Part and DSS2".

In at least one embodiment, the broadband switches are equipped with signaling interworking units. These units translate SS7 messages into B-ISDN messages. In that event, the CCP could transmit SS7 to the broadband switches which could convert the signals properly. Interworking is discussed in ITU-TS Recommendation Q.2660, "B-ISDN, B-ISUP to N-ISUP Interworking".

In one embodiment, the broadband switches may select the actual virtual connection that corresponds through a mux to a DS0 port. This DS0 port could be on a narrowband switch or a on a point, such as a LEC switch. In this case, the CCP would not need to select a DS0 port since the broadband switch was in effect doing so. The internal tables of the broadband switches would be programmed to trigger when the particular broadband switch was connecting to particular broadband connections. These connections might be to a DS0 port on a narrowband switch or any specified point. Upon the trigger, the broadband switch would signal the CCP of the broadband connection it has used. The CCP would incorporate this information into the signal it sends to the narrowband switch or specified point. It is preferred that the CCP select the DS0 port on the selected narrowband switches, and that the broadband switches be allowed to select the broadband connection out of the network (through a mux) and signal the CCP of its selection.

The SS7 message from the LEC informed the CCP which DS0 port had been seized (the CIC), on which IXC device (DPC), and by which LEC switch (the OPC). By tracking the DS0 Port through the mux (**#380** on FIG. **3**), the CCP knows which connection the communication path will use to get to the broadband switch (**#360** on FIG. **3**). The CCP provides the broadband network with the proper signaling to extend the communication path from this switch to the selected narrowband switch as shown in box **635**.

Box **630** shows that the CCP formulates an SS7 message based on the selections relating to the narrowband switch. SS7 message formulation methods, such as drop and insert, are known in the art. A new DPC is inserted that will designate the narrowband switch selected by the CCP. A new CIC is inserted that will designate the DS0 port on that switch as selected by the CCP. The SS7 message is sent to the narrowband switch in box **640**.

As such, the communication path is extended from the LEC through the broadband network to the narrow band switch and the narrowband switch is notified of the incoming communication path. Another portion of the SS7 message contains call information including ANI and DNIS. This information was supplied by the LEC and is in the SS7 message sent to the narrowband switch.

The narrowband switch uses this information along with its own programming to switch the call. This switching may include various switching programs and remote databases. The narrowband switch will select a new DPC based on this processing. It will switch the call to a new DS0 port. Previously, this port was connected to a trunk connected to the next narrowband switch in the call routing scenario. However, in the present invention, the DS0 port is connected through a mux to broadband switch. The narrowband switch will place the new DPC in an SS7 message. Along with the new DPC, a new CIC identifying the new DS0 circuit, and a new OPC designating the narrowband switch itself is placed in the SS7 message and sent to the CCP.

FIG. **7** shows the flow of the CCP when extending a communication path from the selected narrowband switch to a point outside of the IXC in one embodiment of the present invention. The SS7 message generated by the narrowband switch after processing the call is received by the CCP in box **700**. In it, the CIC designates the DS0 port the communications path extends from on the narrowband switch. Because this port is connected to a mux with corresponding connections, the CCP can determine which connection the communication path uses to extend back to the broadband switch.

The CCP may also receive status information from the broadband switches as shown in box **705**. This information allows the CCP to select broadband connections if desired. As discussed, the broadband switches may make these selections. Typically, the broadband switches will use internal tables to select broadband connections based on information in the signal from the CCP. Such information might specify destination code. The destination code might correspond to a terminating switch or a LEC switch to which the communication path should be extended.

As shown in box **710**, the CCP applies processing and selects the appropriate destination for the broadband network to extend the communication path to as shown in box **715**. The CCP may use the new DPC provided by the narrowband switch to identify the destination for the broadband communication path.

In box **720**, signals. are generated reflecting this selection and sent to the appropriate broadband switches in box **725**. As discussed, the broadband switch may trigger and signal the CCP when it uses particular connections. This would occur for a connection through a mux to a LEC switch. This signal is accepted by the CCP in box **730** and is used to identify the DS0 port. An SS7 message is formulated in box **735** and in it the CIC will identify this DS0 connection on the LEC switch (**#335** on FIG. **3**). Alternatively, this DS0 port may have been selected by the CCP and signalled to the broadband switch. The LEC is signalled in box **740**

From FIGS. **6** and **7**, a sequence is shown that demonstrates the procedures that the CCP can follow to accept signaling from the LEC and make selections that control communications through the IXC network. The CCP must produce signals to implement its selections and transmit them to the applicable network elements. The CCP is able to use the outing, billing, and service features of a narrowband switch, but is still is able to employ a broadband network to make a substantial part of the communications path.

FIG. **8** is a flow diagram of CCP signal processing in one embodiment of the invention. Box **800** shows that an SS7 signal has been accepted by the CCP. Box **805** shows that the CCP determines the message type. If the message is not a call message, it is routed or used to update the CCP memory if appropriate as shown in box **810**. Non-call messages are familiar to those skilled in the art with examples being filler or management messages. If the SS7 message is a call message, it is examined to determine if it is an initial address message (IAM) in box **815**. Call messages and IAMs are familiar to those skilled in the art. If it is an IAM, the information provided by automatic number identification (ANI) is used to validate the call in box **820**. ANI validation is accomplished with a table look-up and is well known. If invalid, the communication path is terminated as shown in box **825**.

Once an IAM with a valid ANI is determined, a table is entered which yields an OPC—DPC—CIC combination as shown in box **830**. One skilled in the art will recognize that such a table can take many forms. One example is to set up a table with every combination of OPC—DPC—CIC on one side. The table is entered using OPC—DPC—CIC of the incoming IAM message. After entry through these fields is accomplished, the table yields a new OPC—DPC—CIC which can be formulated into the SS7 message and sent to the switching network as shown in box **835**. The switching network is capable of using this information to make connections.

Once the IAM signal has been processed, subsequent SS7 messaging, can be processed by a separate CIC look-up table entered using the CIC as shown in box **840**. Subsequent messages, such as address complete, answer, release, and release complete can be processed by entering the CIC table using the CIC in these non-IAM signals. For signals directed to the first point, the table yields the original OPC which is used as the DPC. Additionally, subsequent. messages from the first point enter the CIC table using their CIC, and the table yields the DPC previously selected by the CCP for the IAM processing. The CIC table is constantly updated to reflect current processing as shown in box **845**. In this way, the CCP is able to efficiently process non-IAMs because theses signals only need to reflect the results of previous IAM selections.

There can be exceptions to the use of the CIC table for non-IAM call messages. One example would be if a new connection is allowed after release. In that case, the IAM procedures would be followed.

Those skilled in the art will recognize the numerous factors that can be used to design and load the tables. Different OPC—DPC—CIC combinations can be yielded by the tables based on many factors. Some of these factors are: called number, time of day, CPU occupancy, switch status, trunk status, automatic call distribution, operational control, error conditions, network alarms, user requests, and network element status.

For example, if a certain switch must be taken out of service, it is merely replaced in the table with suitable substitutes. The switch is then effectively taken out of service because it is no longer selected. If the CPU loading of a certain switch reaches a threshold, its presence in the tables can be diminished and distributed to other switches.

In another example, if it is busy hour in region A, the tables may yield network elements in region B to process the call. This can be accomplished by adding an area code or a dialed number entry, and time of day entry in the table. For calls placed from an OPC in region A to an area code or dialed number in region B, a narrowband switch in region B could be selected. As such, the DPC yielded by the table during this time frame should reflect a region B narrowband switch. Also, for calls placed from an OPC in region B to an area code or dialed number in region A, the tables should provide the DPC of a region B narrowband switch.

In a preferred embodiment, IAM messages would cause the CCP to query an SCP, data element, or database for support. The SCP would answer the query by using tables as discussed above. The answers would be sent to the CCP and used to formulate signaling. Subsequent messages would be then handled by the CCP using the CIC table. An example of such support would be for the CCP to query the SCP in response to receiving an IAM message. The query may include the OPC, CIC, DPC, and the area code, or dialed number. The SCP could use this information to select network characteristics and avoid busy regions as described in the above busy region example. For example, the SCP would maintain tables for OPC—dialed area code—time of day combinations that would yield a new DPC and CIC. This assumes that busy hour in a region corresponds to time of day, but other factors and yields could also be involved.

In one embodiment, the dialed number or area code could be used to select the new DPC, and time stamps could be placed in the signaling. This might entail tables with OPC—dialed area code entries that yield a new DPC and CIC. In this case, narrowband switches may not even be needed since billing can be applied using the time stamps. The CCP could then route the call directly using only the broadband network. This is especially relevant for POTS calls in which only an area code entry would need to be added to the tables.

As discussed above, often a connection will consist of two separate connection procedures. One connection procedure will be from the origination to a selected network element. The other connection procedure will be from the selected network element to the destination. Also it has been disclosed that the CCP could actually be discreet machines located regionally. In these cases, the CCP device processing the first connection procedure could be located in the origination region, and the CCP device that processes the second connection procedure could be located in the region of the selected network element.

The present invention offers the advantage of separating at least a portion of the communication control from the communication path. By examining and translating signaling independently of the communication path, multiple switches and network elements can be connected in the optimum way. Communications paths are no longer limited to only the connections the switches can control. Networks do not have to wait for standardization among signaling and interface protocols.

The present invention allows for the selection of network characteristics, such as network elements and connections, before switches process or apply the signaling. The switches are not required to have a capability either to make selections or to signal each other. The switches only make connections as directed by the CCP which signals in each switches own signaling format. Various criteria can be used for the selections in the CCP, such as time of day, load balancing, or invalid ANI. As such, the present invention allows for a smooth transition from narrowband to broadband networks. It also allows for the selection of network elements, such as servers and enhanced services platforms.

The present invention represents a fundamental and powerful departure from previous telecommunications technology. By separating the communications path from communication control, the CCP can utilize different networks, and network devices, intelligently. Previously telecommunications systems have been dependent on the switches to accomplish communication control. As such, telecommunications systems have had to wait for the switches to develop communication control before new technology could be implemented. Switches have always been required to physically make connections and provide control over which connections are required. Switch capabilities have not been able to keep up with all of the network possibilities available. The result is a limited system.

Switches have been given support in this dual task. SCPs, STPs, and adjunct processors provide support for communication control. However, these devices only support the switches communication control, and the switch remains essential to communication control. This dependence has created a bottleneck given the available network possibilities.

One advantage of the present invention is that it allows narrowband switches be used interchangeably in a narrowband/broadband hybrid network. Any narrowband switch may be taken out of service without re-routing traffic and changing routing logic in each switch. The CCP is simply programmed not to select the given narrowband switch for call processing. The CCP will route calls over the broadband network to another narrowband switch. This flexibility also allows the telecommunications network to easily transfer narrowband switch loads.

An important advantage of this system is that both the advantages of broadband and narrowband systems are utilized. The transmission capabilities of a broadband network are coupled with the narrowband network's ability to apply features. For example, the CCP can use the broadband network to substantially make the call connection from origination to destination. The CCP diverts the traffic to the. narrowband network for processing. The narrowband network can apply features, such as billing and routing. Once processed, the traffic is directed back to the broadband network for completion of the connection. The CCP can then use the routing information generated by the narrow band system to route the traffic through the broadband system to the destination. As a result, the telecommunications system does not have to develop a billing or "800" routing feature for its broadband network. This can be accomplished because the CCP allows both networks to work together intelligently.

Another advantage of the present invention is the elimination of a substantial percentage of the DS0 ports required on the existing narrowband switches. In the current architectures, narrowband switches are interconnected to each other. A substantial percentage of the switch ports are taken up by these connections. By eliminating the need for the switches to connect to each other, these ports can be eliminated. Each narrowband switch is only connected to the broadband system. This architecture requires fewer ports per switch. By load balancing with the CCP, the number of ports required on busy switches can be reduced. The architecture in the present invention does require additional broadband ports, but these can be added at a significant cost saving versus narrowband ports.

Additionally, the narrowband switches no longer signal each other since all signaling is directed to the CCP. This concentration accounts for a reduction in required signaling link ports. This reduction possibly could result in the elimination of STPs.

As mentioned above, an advantage of the present invention is its ability to treat narrowband switches, or groups of narrowband switches, interchangeably. The CCP can pick any narrowband switch to process a particular call. This allows the network to pull narrowband switches out of service without taking extreme measures. In turn, this simplifies the introduction of new services into the network. A switch can be pulled out of service simply by instructing the CCP to stop selecting it. The switch can be re-programmed and put back into service. Then the next switch can then be updated in the same manner until all of the switches are implementing the new service. Switches can also be easily pulled to test developing applications.

This narrowband switch flexibility also allows the CCP to balance switch loads through the network during peak times, or during mass calling events. This eliminates the need to implement complex and expensive load balancing features in the narrowband network. Instead of programming the several switches to balance among themselves, one command to the CCP can achieve this.

Another advantage is the reduction in call set-up time. Most large networks require that a call pass through more than two narrowband switches arranged in a hierarchical fashion. One large network employs a flat architecture in which all narrowband switches are interconnected, but this still requires that the call pass through two narrowband switches. In the present invention, only one narrowband switch is required for each call. The use of broadband switches to set-up and complete the call represents significant time savings.

What is claimed is:

1. A method of operating a processing system to control a packet communication system for a user communication, the method comprising:

receiving a signaling message for the user communication from a narrowband communication system into the processing system;

processing the signaling message to select a network code that identifies a network element to provide egress from the packet communication system for the user communication;

generating a control message indicating the network code;

transferring the control message from the processing system to the packet communication system

receiving the user communication in the packet communication system and using the network code to route the user communication through the packet communication system to the network element; and

transferring the user communication from the network element to provide egress from the packet communication system.

2. The method of claim 1 wherein processing the signaling message comprises processing an Initial Address Message (IAM).

3. The method of claim 1 wherein processing the signaling message comprises processing a Signaling System #7 (SS7) message.

4. The method of claim 1 wherein processing the signaling message comprises processing a Q.931 message.

5. The method of claim 1 wherein processing the signaling message comprises processing in-band signaling.

6. The method of claim 1 wherein processing the signaling message to select the network code comprises processing caller number information in the signaling message.

7. The method of claim 1 wherein processing the signaling message to select the network code comprises processing called number information in the signaling message.

8. The method of claim 1 wherein processing the signaling message to select the network code comprises processing a point code in the signaling message.

9. The method of claim 1 wherein processing the signaling message to select the network code comprises processing a circuit identification code in the signaling message.

10. The method of claim 1 wherein processing the signaling message to select the network code comprises generating and transferring a query to a service control point and receiving and processing a response from the service control point.

11. The method of claim 1 further comprising processing geographic information to select the network code.

12. The method of claim 1 further comprising processing load balancing information to select the network code.

13. The method of claim 1 further comprising processing time of day information to select the network code.

14. The method of claim 1 further comprising processing a network alarm to select the network code.

15. The method of claim **1** wherein the network code comprises a logical address of the network element.

16. The method of claim **1** further comprising processing the signaling message to select a DS0 connection to provide the egress from the packet communication system.

17. The method of claim **1** further comprising processing the signaling message to select a wireless connection to provide the egress from the packet communication system.

18. The method of claim **1** wherein the network element comprises a switch.

19. The method of claim **1** wherein the network element comprises a multiplexer.

20. The method of claim **1** wherein the network element comprises a server.

21. The method of claim **1** wherein the network element comprises a service platform.

22. The method of claim **1** wherein the user communication comprises voice.

23. The method of claim **1** wherein the processing system is external to any communication switches.

24. A method of operating a processing system to control a packet communication system for a user communication, the method comprising:

selecting a network code that identifies a network element to provide egress for the user communication from the packet communication system to a narrowband communication system;

generating a control message indicating the network code and transferring the control message from the processing system to the packet communication system; and

generating a signaling message for the user communication and transferring the signaling message from the processing system to the narrowband communication system;

receiving the user communication in the packet communication system and using the network code to route the user communication through the packet communication system to the network element; and

transferring the user communication from the network element to the narrowband communication system to provide egress from the the packet communication system.

25. The method of claim **24** wherein generating and transferring the signaling message comprises generating and transferring an Initial Address Message (IAM).

26. The method of claim **24** wherein generating and transferring the signaling message comprises generating and transferring a Signaling System #7 (SS7)message.

27. The method of claim **24** wherein generating and transferring the signaling message comprises generating and transferring a Q.931 message.

28. The method of claim **24** wherein generating and transferring the signaling message comprises generating and transferring in-band signaling.

29. The method of claim **24** wherein the network code comprises a logical address of the network element.

30. The method of claim **24** further comprising selecting a DS0 connection to provide the egress from the packet communication system and identifying the DS0 in the signaling message.

31. The method of claim **24** further comprising selecting a wireless connection to provide the egress from the packet communication system and identifying the wireless message in the signaling message.

32. The method of claim **24** wherein the network element comprises a switch.

33. The method of claim **24** wherein the network element comprises a multiplexer.

34. The method of claim **24** wherein the network element comprises a server.

35. The method of claim **24** wherein the network element comprises a service platform.

36. The method of claim **24** wherein the user communication comprises voice.

37. The method of claim **24** wherein the user communication comprises data.

38. The method of claim **24** wherein the processing system is external to any communication switches.

* * * * *

EXHIBIT 32

PTO/SB/05 (05-03)
Approved for use through 04/30/2003. OMB 0651-0032
U.S. Patent and Trademark Office. U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. 1.53(b))

Attorney Docket No.	1057p
First Inventor	Joseph Michael Christie
Title	Method, System and Apparatus for Telecommunications Control
Express Mail Label No.	EV 335506095 US

21989 U.S. PTO 10/633798 08/04/03

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

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1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)
   (Submit an original and a duplicate for fee processing)
2. ☐ Applicant claims small entity status. See 37 CFR 1.27.
3. ☒ Specification [*Total Pages* 36]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. ☒ Drawing(s) *(35 U.S.C.113)* [*Total Sheets* 8]
5. Oath or Declaration [*Total Sheets* 1]
   a. ☐ Newly executed (original or copy)
   b. ☒ Copy from a prior application (37 CFR 1.63 (d))
   (for a continuation/divisional with Box 18 completed)
   i. ☐ DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☒ Application Data Sheet. See 37 CFR 1.76
7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program *(Appendix)*
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. ☐ Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
   i. ☐ CD-ROM or CD-R (2 copies); or
   ii. ☐ paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATIONS PARTS

9. ☐ Assignment Papers (cover sheet & document(s))
10. ☐ 37 C.F.R. 3.73(b) Statement *(when there is an assignee)* ☒ Power of Attorney
11. ☐ English Translation Document *(if applicable)*
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other: _____

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: 09 / 082,040

Prior application information: *Examiner* Ajit Patel *Art Unit:* 2664

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

19. CORRESPONDENCE ADDRESS

☒ Customer Number: 28004

Name					
Address					
City		*State*		*Zip Code*	
Country		*Telephone*		*Fax*	

Name (Print/Type)	Michael J. Setter	*Registration No. (Attorney/Agent)*	37,936
Signature	[signature]	*Date*	8/4/03

elements in network 210. One bus-type connection is shown for purposes of clarity, but those skilled in the art are familiar with many actual types of connections to use. Additionally link 256 is shown from CCP 250 to the network elements (260-270). Link 256 is similarly represented as a bus-type link for clarity, and multiple links are actually used, although some network elements may not even require links. Link 214 has been simplified for clarity in the same fashion.

In one embodiment, user 220 may desire to establish a communications path to user 230. CCP 250 would make the appropriate selections and signal the network elements in network 210 as discussed with regard to the embodiments of Figure 1. As a result, a communications path would be established from user 220 to user 230 through network 210 and connections 222 and 232.

In another embodiment, user 220 may desire to access one of the various network elements (260-270). User 220 will typically seize connection 222 to network 210 and generate signaling. Both in-band signaling on connection 222 and out-of-band signaling on link 224 would be directed to CCP 250. By processing the signaling, CCP 250 can select any of the network elements (260-270) and control the communications through network 210 and connection 212 to the network elements (260-270).

For example, should user 220 desire to connect to a video server and another network, user 220 would signal the request. The signaling would be directed to CCP 250 over link 224, or over connection 222 and link 214 as discussed above. CCP 250 would process the signaling and make the appropriate selections. CCP 250 would signal network 210 and video servers 266 of its selections. As a result, a communications path would be set-up from user 220 to video servers 266.

Additionally, CCP 250 would control communications to the other network which is represented by networks 260. Networks 260 could be any other form of telecommunications network -- either public or private. CCP 250 would make the appropriate selections to further the communications path over connection 212 and network 210 to networks 260. Upon signaling from CCP 250, the connections comprising the communications path would be made. Networks 260 would also be signalled by CCP 250 over link 256. As such a communication path is set up from user 230 to video servers 266 and on to networks 260.

There may also be several devices represented by particular network element shown on Figure 2. CCP 250 could also select the particular device to access. For example, take the situation in which voice servers 268 represents 20 individual voice server devices split among three different locations. On each call, CCP 250 could select the actual voice server device which should be used on that call and control the communications through network 210 and connection 212 to the selected device. Alternatively, CCP 250 may only be required to select group of devices, for instance at a particular location, instead of the actual device.

As is known, large telecommunication networks are comprised of numerous network elements, connections, and links. The present invention is suitable for use in this context. Figure 3 shows a version of the present invention in the context of a large network. Typically, this network would be comprised of several broadband switches, narrowband switches, muxes, signal transfer points (STPs), Service Control Points (SCPs), operator centers, video servers, voice servers, adjunct processors, enhanced services platforms, connections, and links. For purposes of clarity, only a few of these possibilities are shown on Figure 3. For the same reason, connections and links are not numbered.

Figure 3 shows Telecommunications Network 310 which is comprised of STP 340, STP 345, CCP 350, SCP 355, broadband switches 360, 362, 364, and 366, interworking units 361 and 365, narrowband switches 370 and 375, and muxes 380, 382, 384, and 386. Aside from CCP 350, these elements of a large network are familiar to one skilled in the art and examples of the of these network elements are as follows: STP -- DSC Communications Megahub; SCP -- Tandem CLX; broadband switch-- Fore Systems ASX-100; narrowband switch -- Northern Telecom DMS-250; and mux -- Digital Link PremisWay with CBR module.

In at least one embodiment, the broadband switches are equipped with signaling interworking units. These units translate SS7 messages into B-ISDN messages. In that event, the CCP could transmit SS7 to the broadband switches which could convert the signals, properly. Interworking is discussed in ITU-TS Recommendation Q.2660, "B-ISDN, B-ISUP to N-ISUP Interworking."

When user information passes from a broadband network to a narrowband network, it typically must pass through a mux. Muxes can convert transmitted information back and forth between narrowband and broadband formats. In at least one embodiment, each broadband connection on one side of a mux corresponds to a narrowband connection on the other side of the mux. In this way, the CCP can track connections through the mux. If the communication path is on a given narrowband connection entering the mux, it will exit the mux on its corresponding broadband connection. This correspondence allows the CCP to identify connections on each side of the mux based on the entry connection. Muxes are typically placed at any interface between narrowband and broadband connections.

As long as the connections correspond through the mux, the CCP can track the communication path properly. Alternatively, the connections may not correspond. In that case, signaling links between the muxes and the CCP would be required for the devices to communicate and allow the CCP to track the communication path.

Additionally, Telecommunications Network 310 includes the connections and links which are not numbered. These connections and links are familiar to those skilled in the art. Some examples of possible connections are switched digital lines, satellite links, microwave links, cellular links, and dedicated digital lines, but there are others. The signaling links are typically data links, such as 56.kilobit lines. The signaling may employ SS7. Broadband, C6, C7, CCIS, Q.933, Q.931, T1.607, Q.2931, B-ISUP or other forms of signaling technology. The present invention is fully operational with the many variations which are well known in the art. Additionally, it is also known that a direct link between two devices can be used instead of an STP for signal routing.

Outside of Telecommunications Network 310 are first point 320, second point 330, LEC switch 325, LEC switch 335, LEC STP 328, and LEC STP 338. These devices are shown along with their links and connections. First point 320 is connected to LEC switch 325. LEC switch 325 is linked to LEC STP 328 which mutes signaling from LEC switch 325. LEC switch 325 is also connected to mux 380 of Telecommunications Network 310. LEC STP 228 is linked to STP 340 of Telecommunications Network 310.

STP 340 is linked to STP 345. The other links are as follows. STPs 340 and 345 are linked to CCP 350. CCP 350 is linked to interworking units 361 and 365 of broadband switches

EXHIBIT 33

REDACTED IN ITS ENTIRETY

EXHIBIT 34

US005991301A

United States Patent [19]

Christie

[11] **Patent Number: 5,991,301**

[45] **Date of Patent: *Nov. 23, 1999**

[54] **BROADBAND TELECOMMUNICATIONS SYSTEM**

[75] Inventor: **Joseph Michael Christie**, San Bruno, Calif.

[73] Assignee: **Sprint Communications Co. L.P.**, K.C., Mo.

[*] Notice: This patent is subject to a terminal disclaimer.

[21] Appl. No.: **08/525,897**

[22] Filed: **Sep. 8, 1995**

Related U.S. Application Data

[63] Continuation-in-part of application No. 08/238,605, May 5, 1994, abandoned.

[51] **Int. Cl.**[6] **H04L 12/56**; H04L 12/28

[52] **U.S. Cl.** **370/395**; 370/410; 370/466

[58] **Field of Search** 370/17, 24, 58.2, 370/68.1, 110.1, 60, 60.1, 94.1, 94.2, 79, 84, 85.13, 351, 352–360, 395, 396, 397, 398, 399, 465, 466, 467, 410, 389; 379/220, 229, 230

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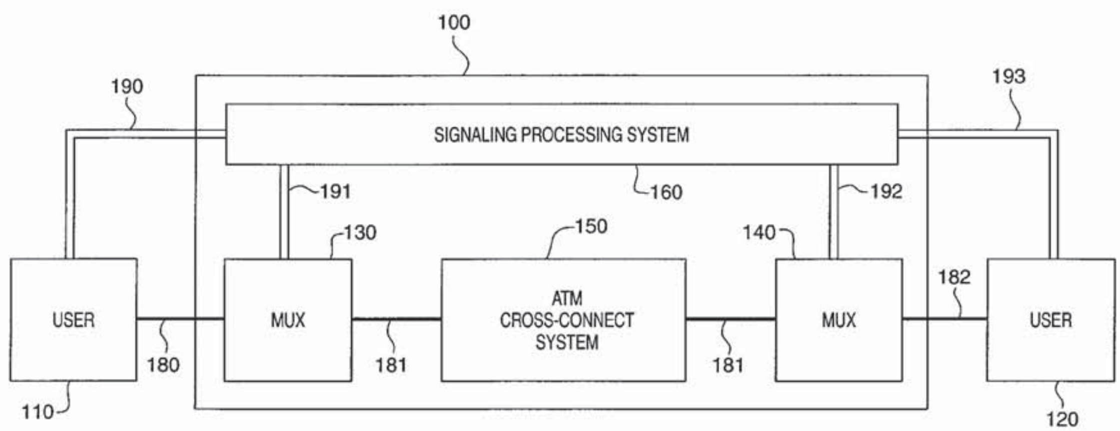
Primary Examiner—Ajit Patel
Attorney, Agent, or Firm—Harley R. Ball; Bruce C. McClelland

[57] **ABSTRACT**

The invention is a system for providing virtual connections through an ATM interworking multiplexer on a call-by-call basis. A signaling processor receives signaling for a call and selects the virtual connection for the call. The signaling processor generates new signaling that identifies the selection and transfers the new signaling to the ATM interworking multiplexer that accepted the access connection for the call. The multiplexer converts user information from the access connection into ATM cells for transmission over the virtual connection in accord with the new signaling.

47 Claims, 12 Drawing Sheets



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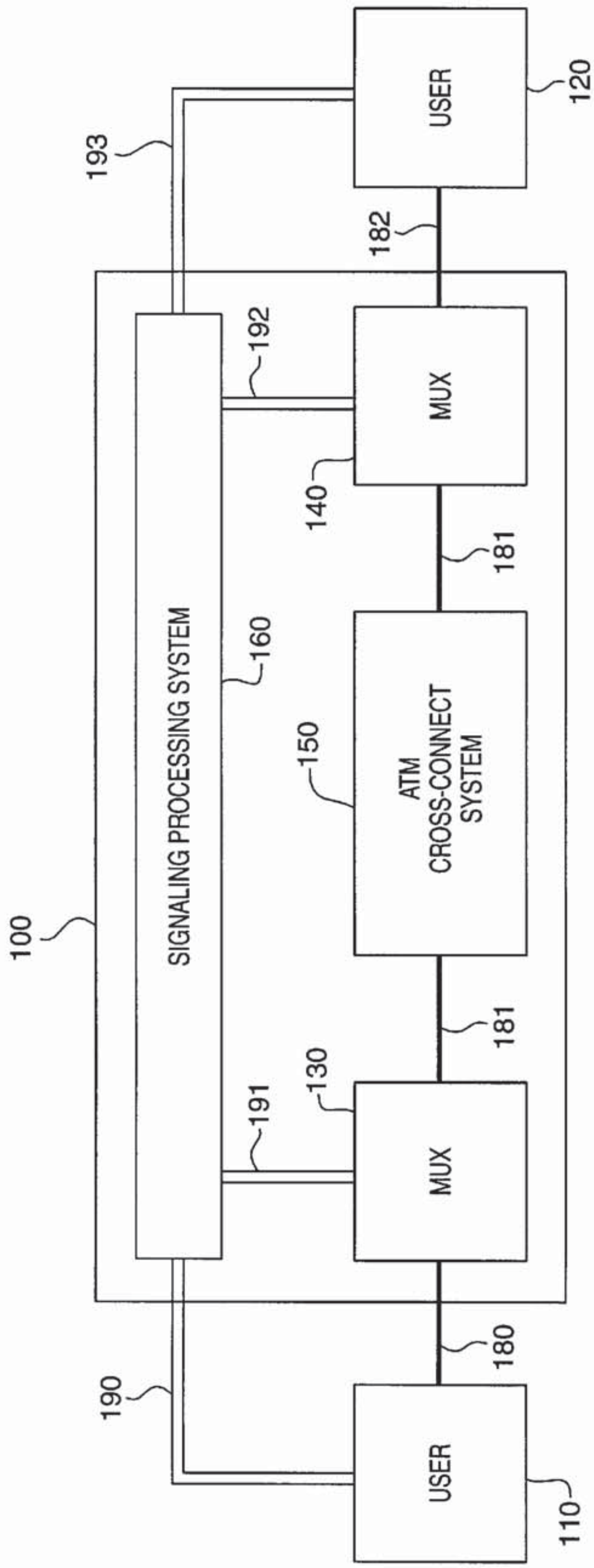
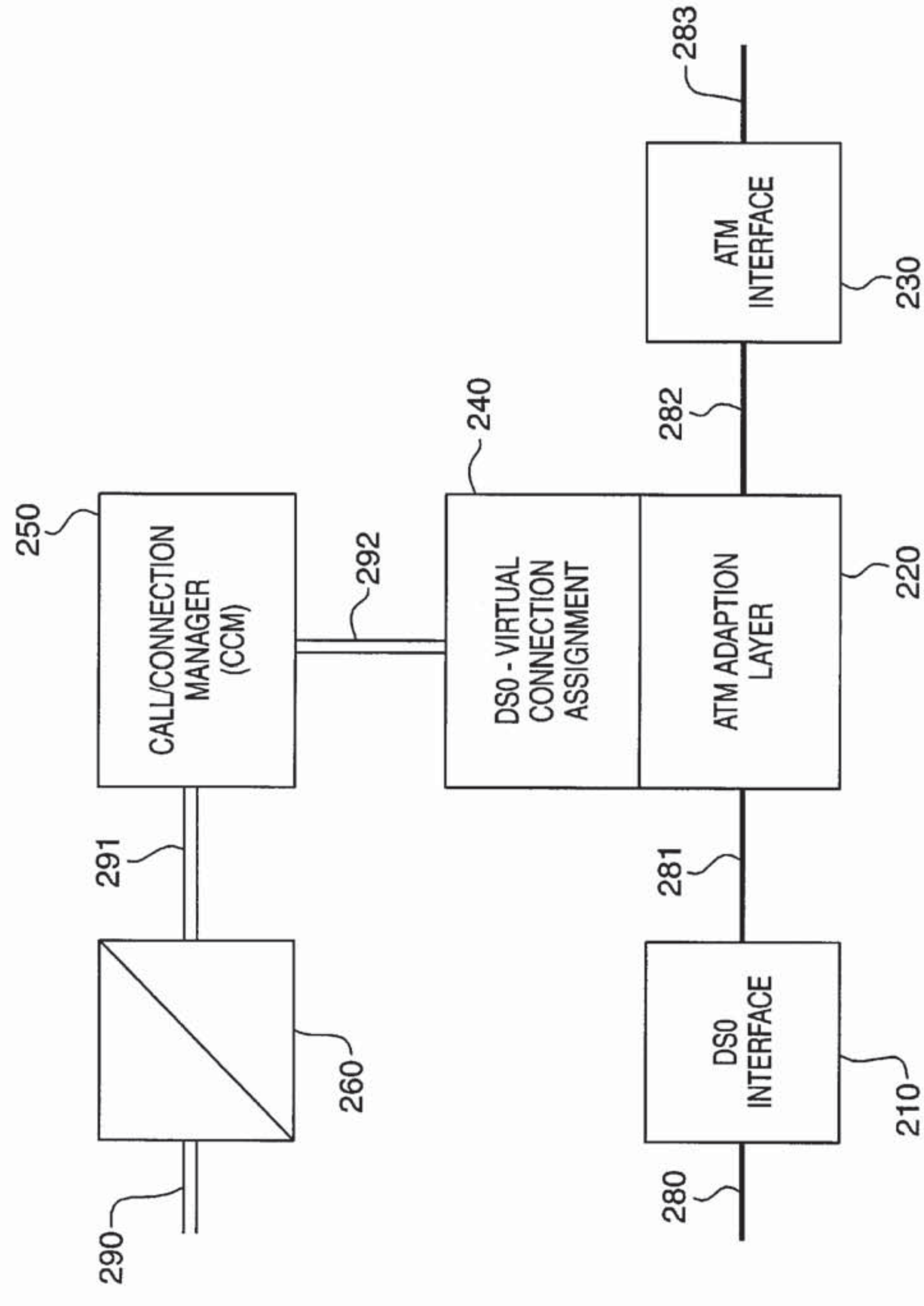

USER
120
193
182
192
MUX
140
181
SIGNALING PROCESSING SYSTEM
160
150
ATM
CROSS-CONNECT
SYSTEM
100
181
130
191
MUX
180
190
USER
110

FIG. 1



CALL/CONNECTION MANAGER (CCM)
DS0 - VIRTUAL CONNECTION ASSIGNMENT
ATM ADAPTION LAYER
ATM INTERFACE
DS0 INTERFACE
250
240
292
291
290
260
283
282
281
280
230
220
210

FIG. 2

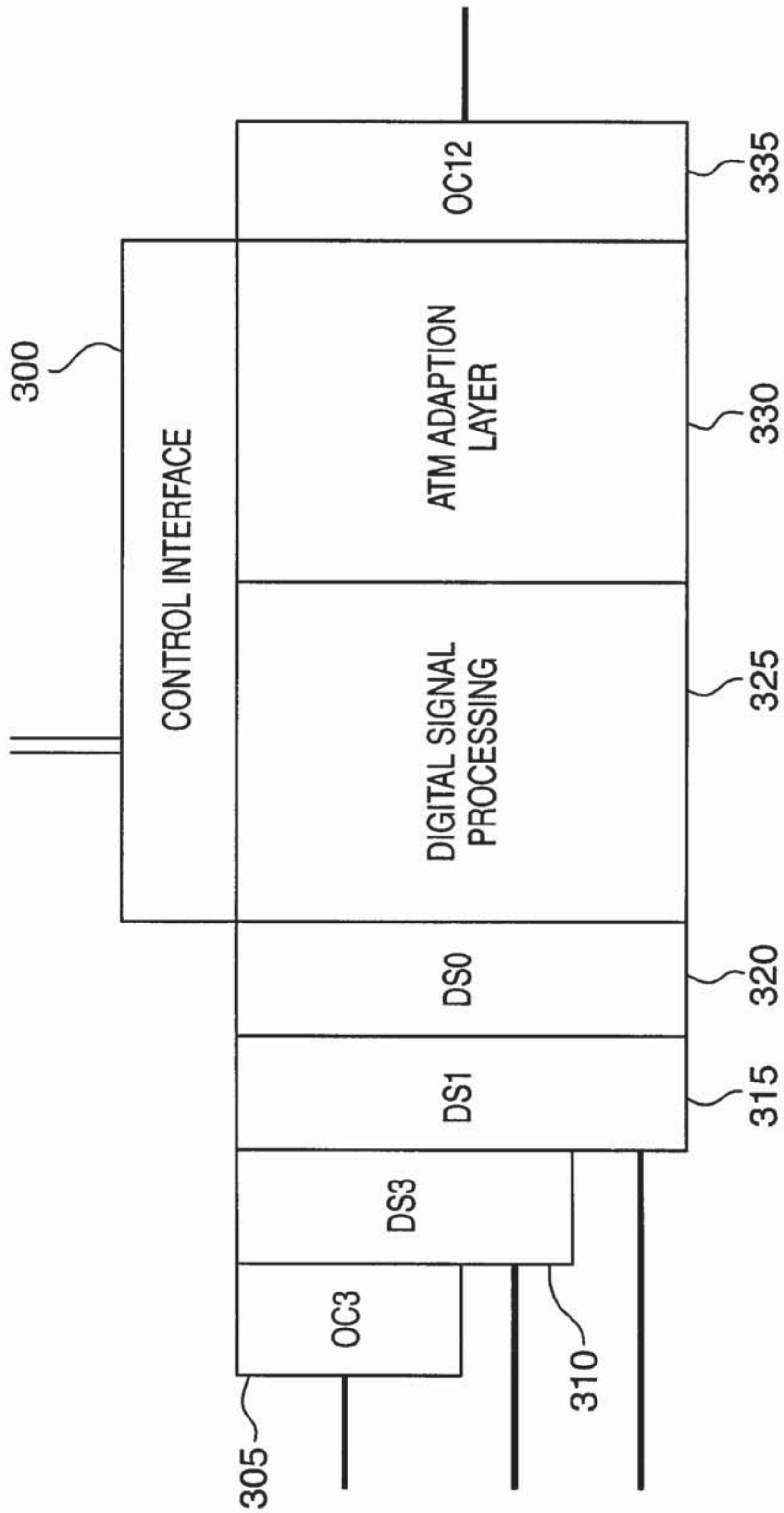

300
CONTROL INTERFACE
OC12
ATM ADAPTION LAYER
DIGITAL SIGNAL PROCESSING
DS0
DS1
DS3
OC3
335
330
325
320
315
310
305

FIG. 3

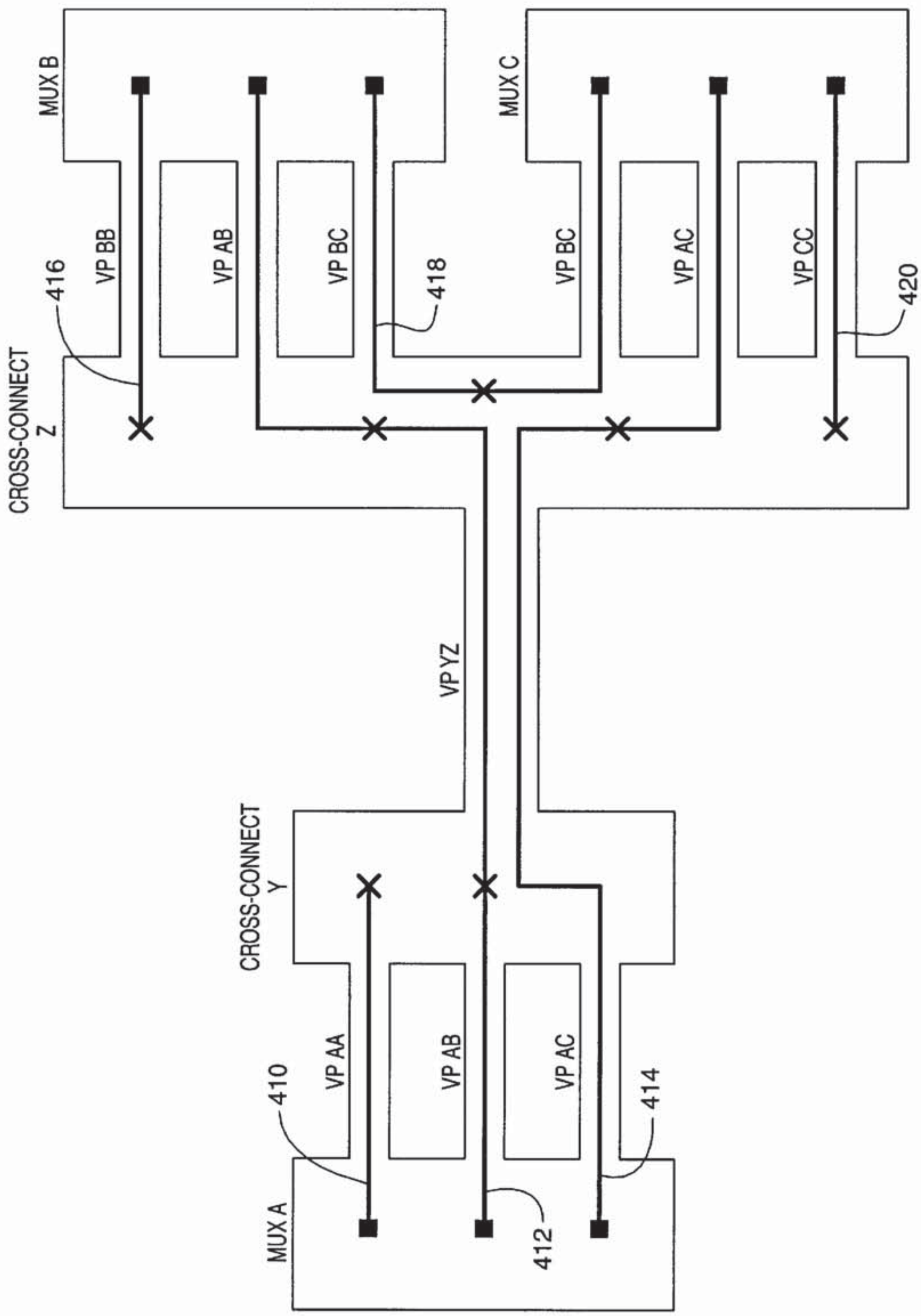

MUX B
MUX C
VP BB
VP AB
VP BC
VP BC
VP AC
VP CC
416
418
420
CROSS-CONNECT Z
VP YZ
CROSS-CONNECT Y
VP AA
VP AB
VP AC
410
412
414
MUX A

FIG. 4

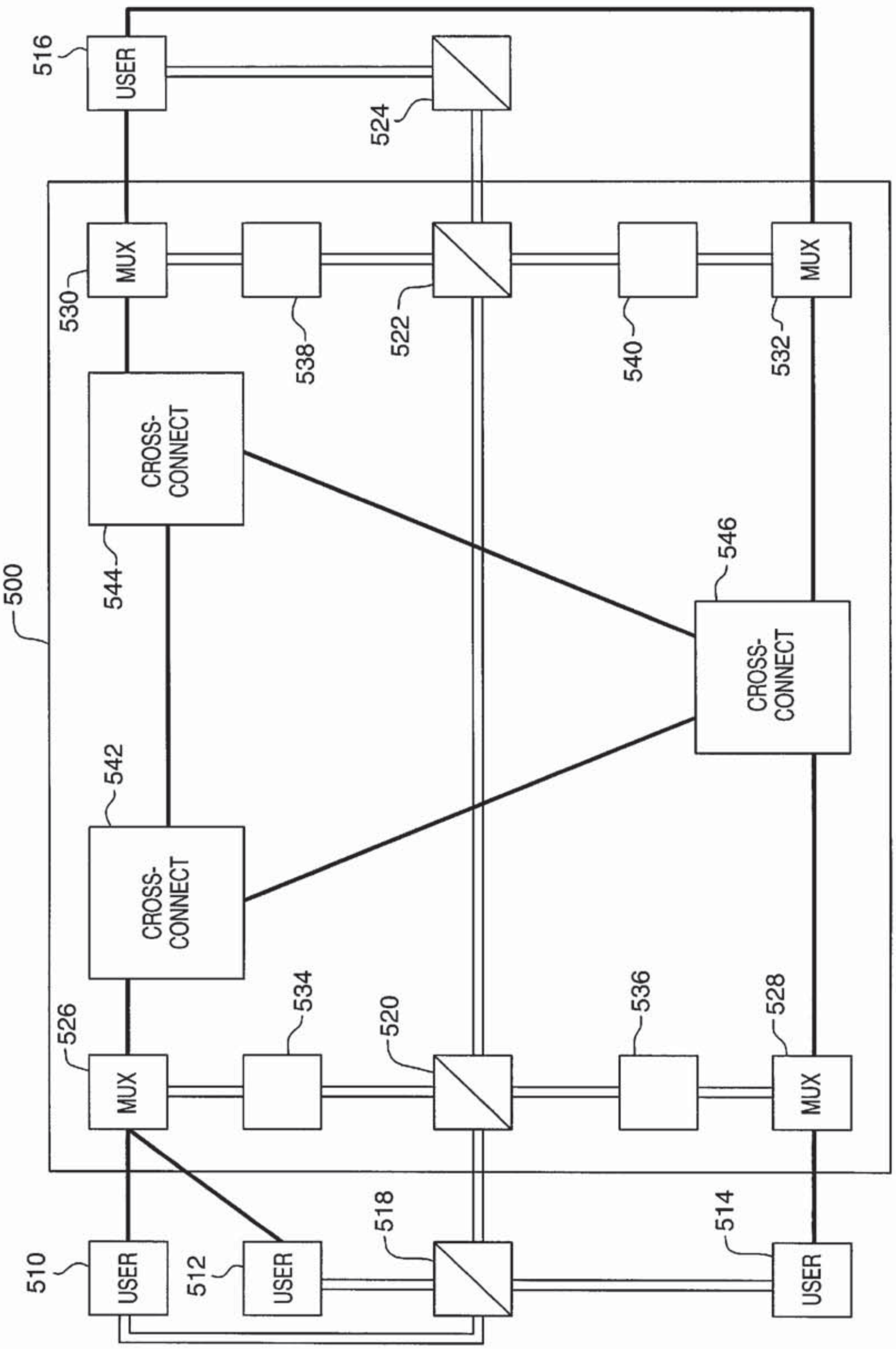
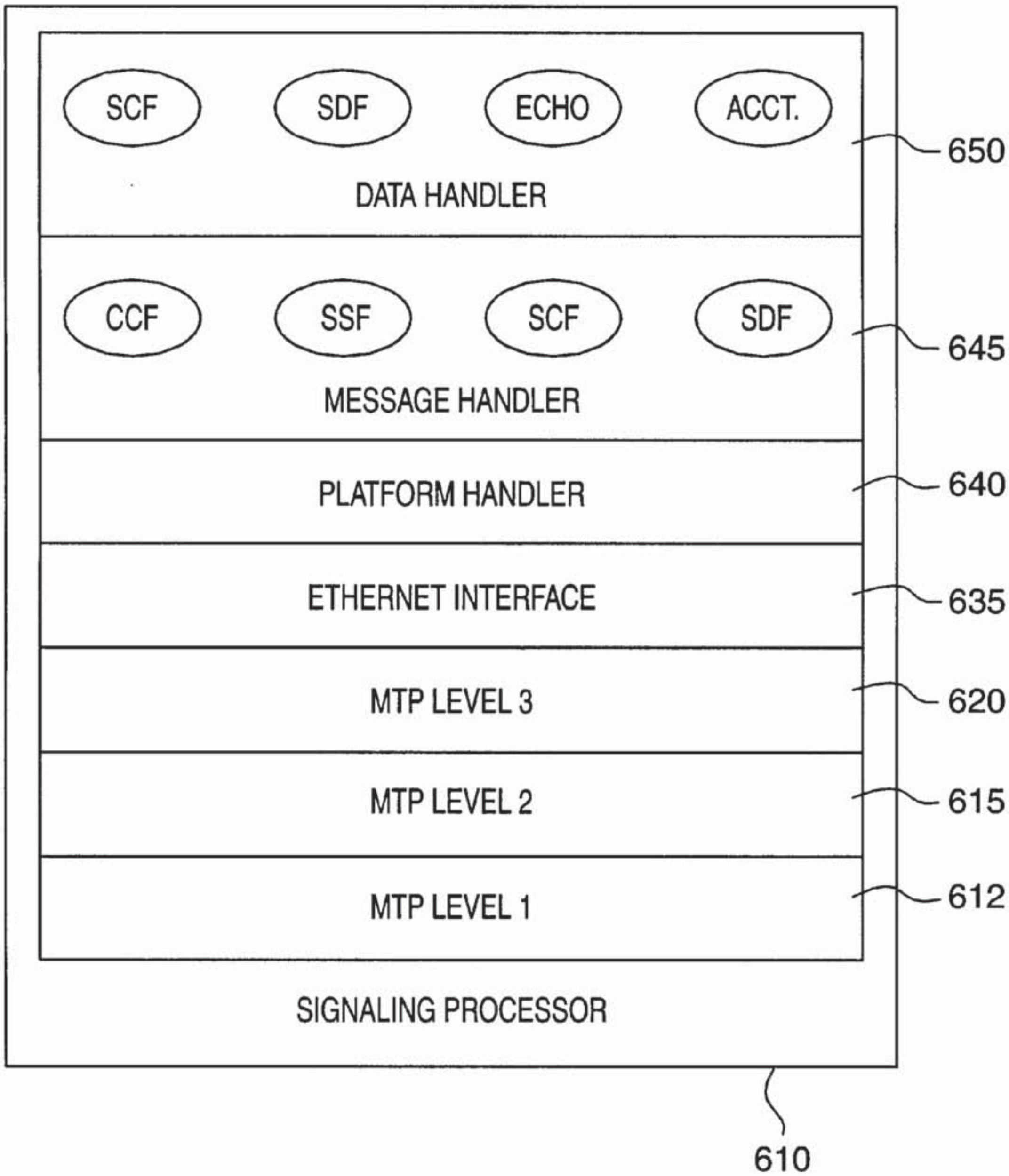
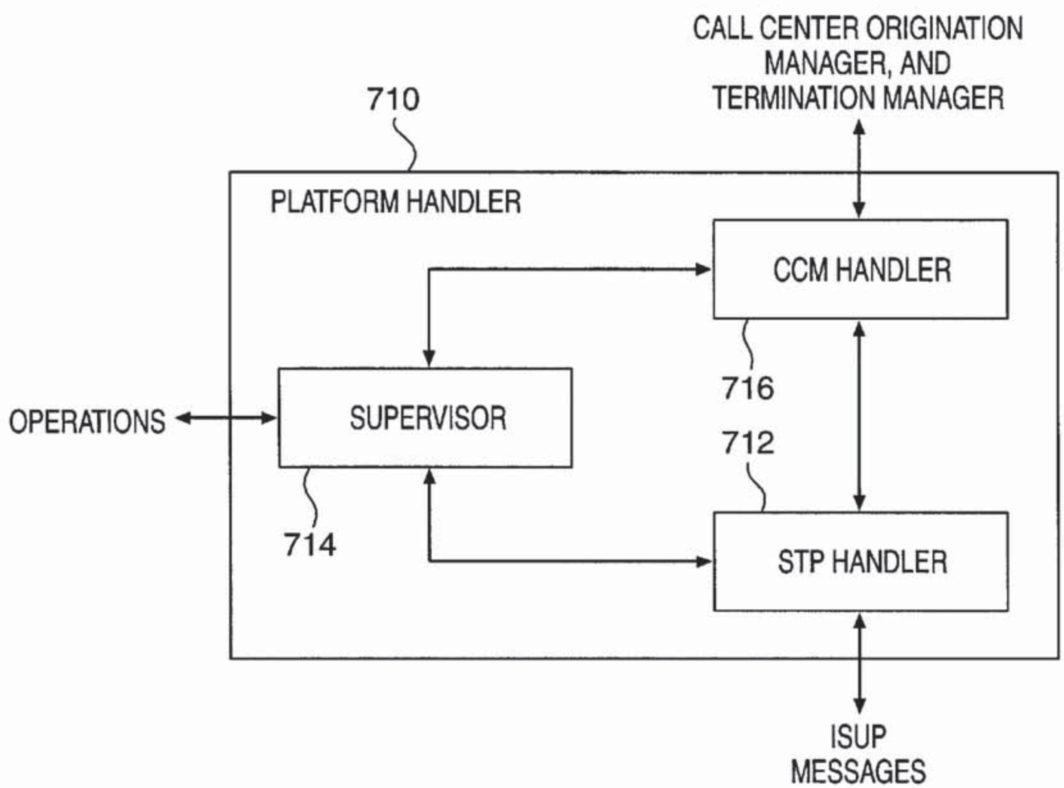

516
USER
524
530
MUX
538
522
540
532
MUX
CROSS-CONNECT
544
500
546
CROSS-CONNECT
542
CROSS-CONNECT
526
MUX
534
520
536
528
MUX
510
USER
512
USER
518
514
USER

FIG. 5



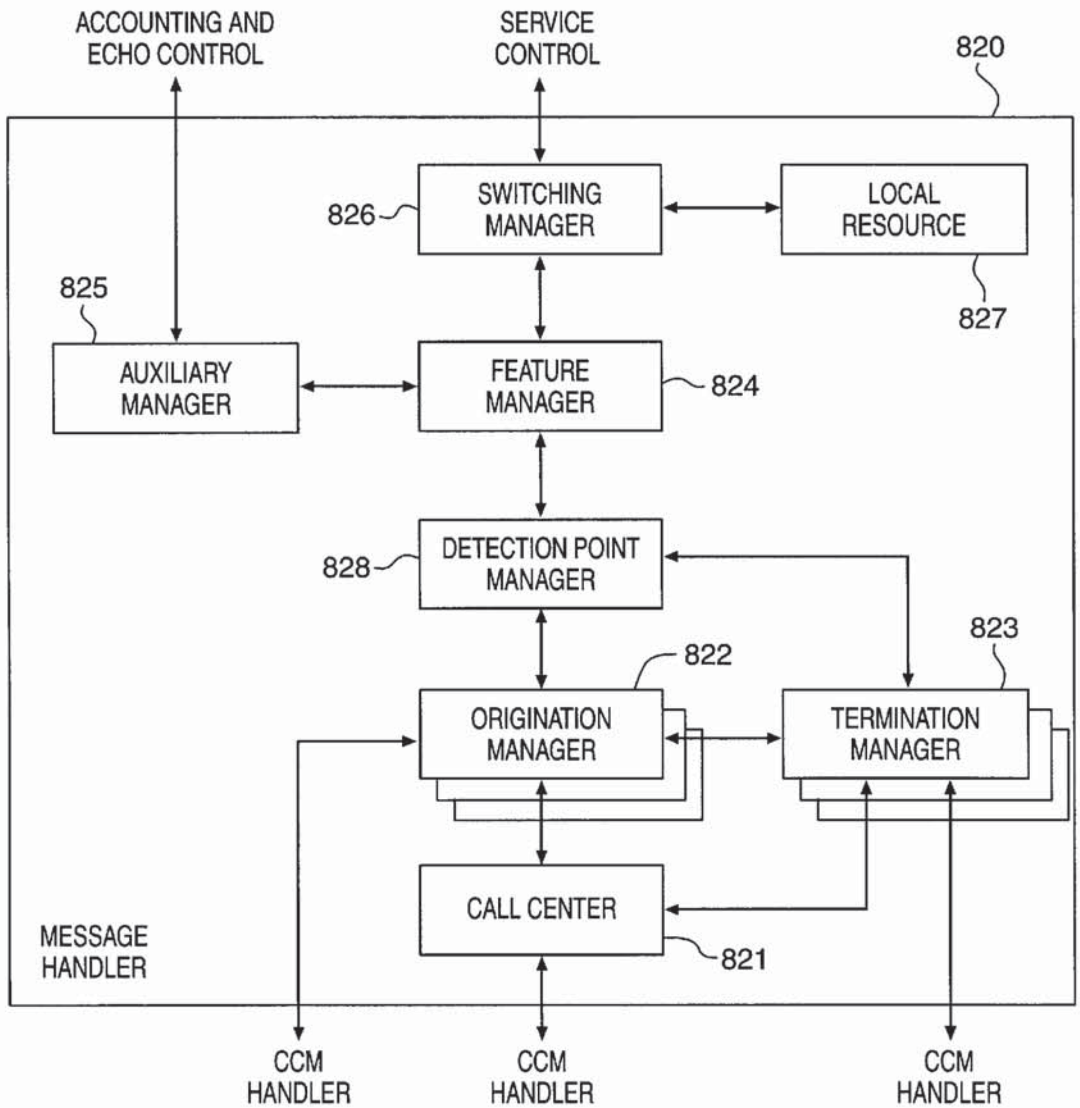
SCF
SDF
ECHO
ACCT.
DATA HANDLER
650
CCF
SSF
SCF
SDF
MESSAGE HANDLER
645
PLATFORM HANDLER
640
ETHERNET INTERFACE
635
MTP LEVEL 3
620
MTP LEVEL 2
615
MTP LEVEL 1
612
SIGNALING PROCESSOR
610

FIG. 6



CALL CENTER ORIGINATION MANAGER, AND TERMINATION MANAGER
710
PLATFORM HANDLER
CCM HANDLER
716
712
OPERATIONS
SUPERVISOR
714
STP HANDLER
ISUP MESSAGES

FIG. 7



ACCOUNTING AND ECHO CONTROL
SERVICE CONTROL
820
SWITCHING MANAGER
826
LOCAL RESOURCE
827
825
AUXILIARY MANAGER
FEATURE MANAGER
824
DETECTION POINT MANAGER
828
823
822
ORIGINATION MANAGER
TERMINATION MANAGER
CALL CENTER
821
MESSAGE HANDLER
CCM HANDLER
CCM HANDLER
CCM HANDLER

FIG. 8

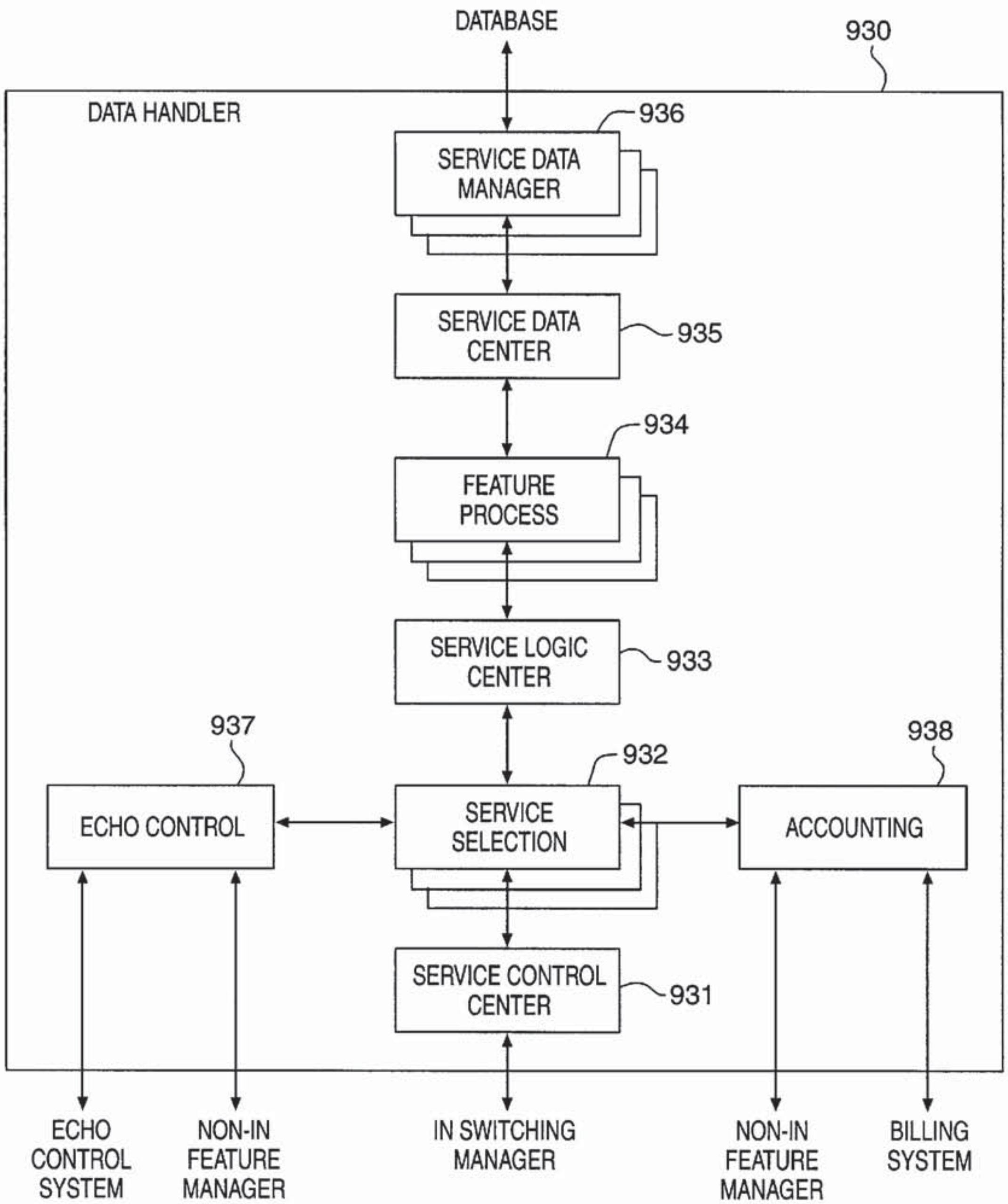

DATABASE
930
DATA HANDLER
936
SERVICE DATA MANAGER
SERVICE DATA CENTER
935
934
FEATURE PROCESS
SERVICE LOGIC CENTER
933
937
938
932
ECHO CONTROL
SERVICE SELECTION
ACCOUNTING
SERVICE CONTROL CENTER
931
ECHO CONTROL SYSTEM
NON-IN FEATURE MANAGER
IN SWITCHING MANAGER
NON-IN FEATURE MANAGER
BILLING SYSTEM

FIG. 9

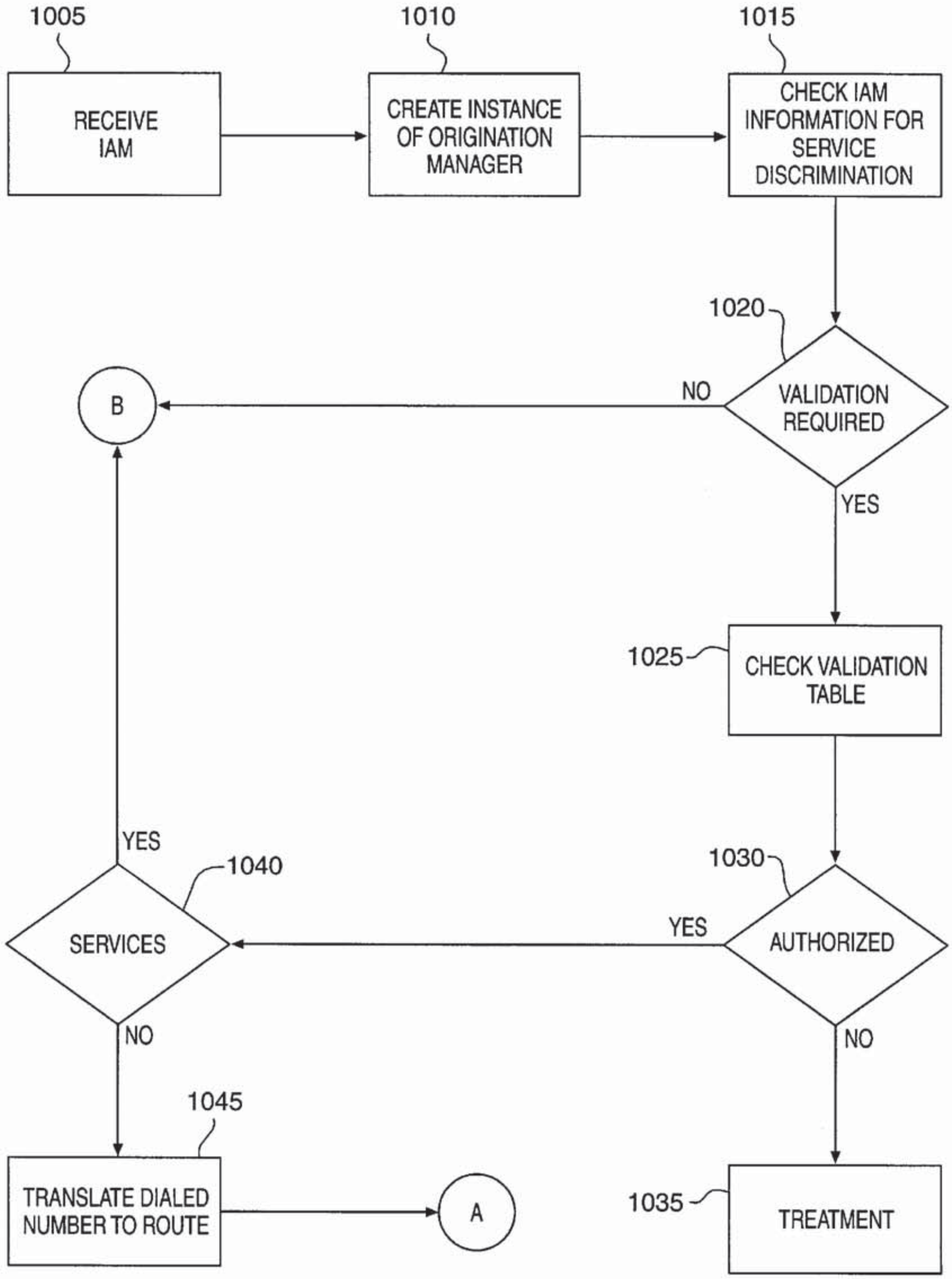

1005
RECEIVE IAM
1010
CREATE INSTANCE OF ORIGINATION MANAGER
1015
CHECK IAM INFORMATION FOR SERVICE DISCRIMINATION
1020
VALIDATION REQUIRED
NO
B
YES
1025
CHECK VALIDATION TABLE
1030
AUTHORIZED
YES
NO
1040
SERVICES
YES
NO
1045
TRANSLATE DIALED NUMBER TO ROUTE
A
1035
TREATMENT

FIG. 10

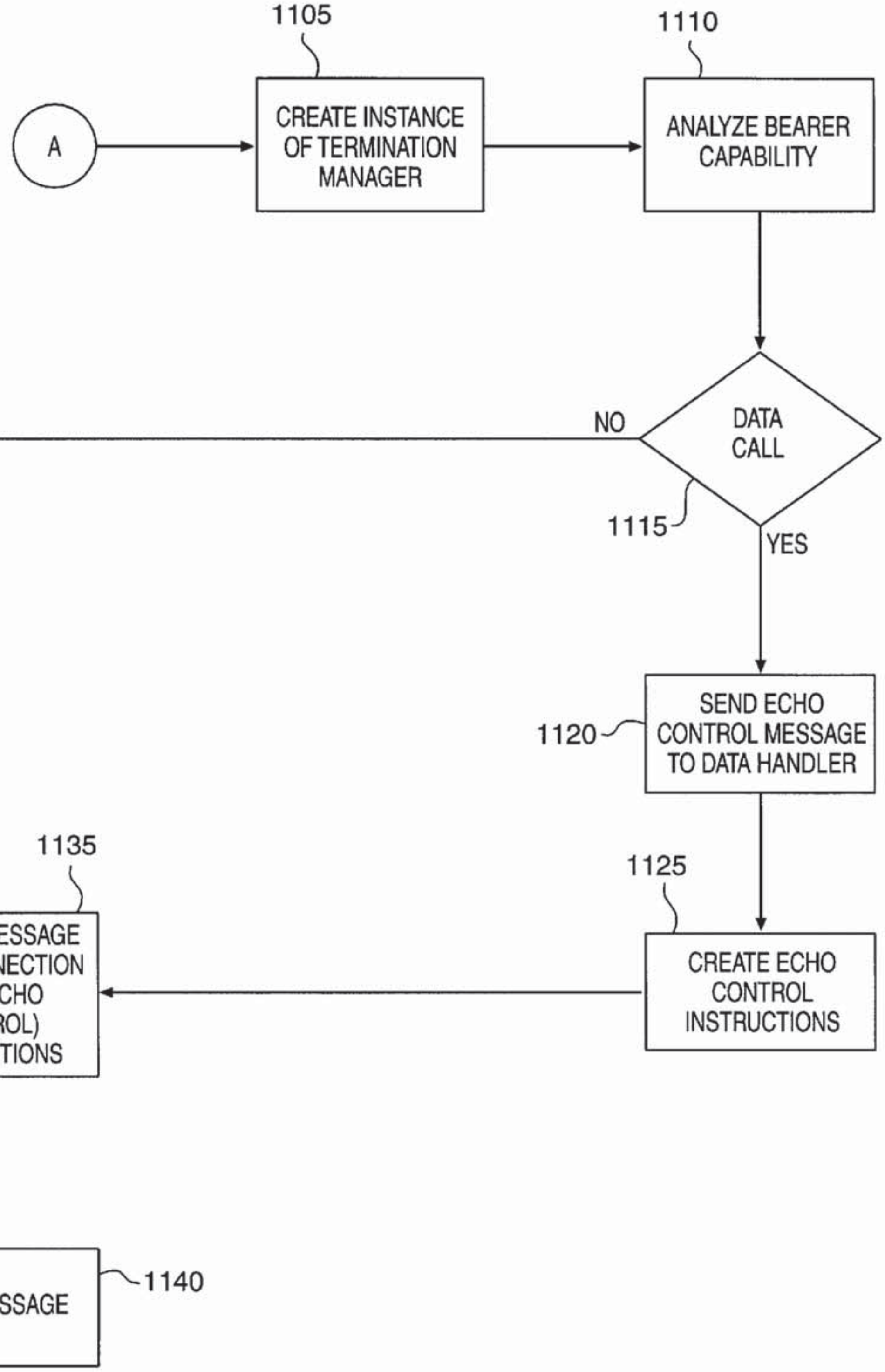

A
1105
CREATE INSTANCE OF TERMINATION MANAGER
1110
ANALYZE BEARER CAPABILITY
DATA CALL
1115
NO
YES
1120
SEND ECHO CONTROL MESSAGE TO DATA HANDLER
1125
CREATE ECHO CONTROL INSTRUCTIONS
1135
CREATE MESSAGE WITH CONNECTION (AND ECHO CONTROL) INSTRUCTIONS
1140
SEND MESSAGE

FIG. 11

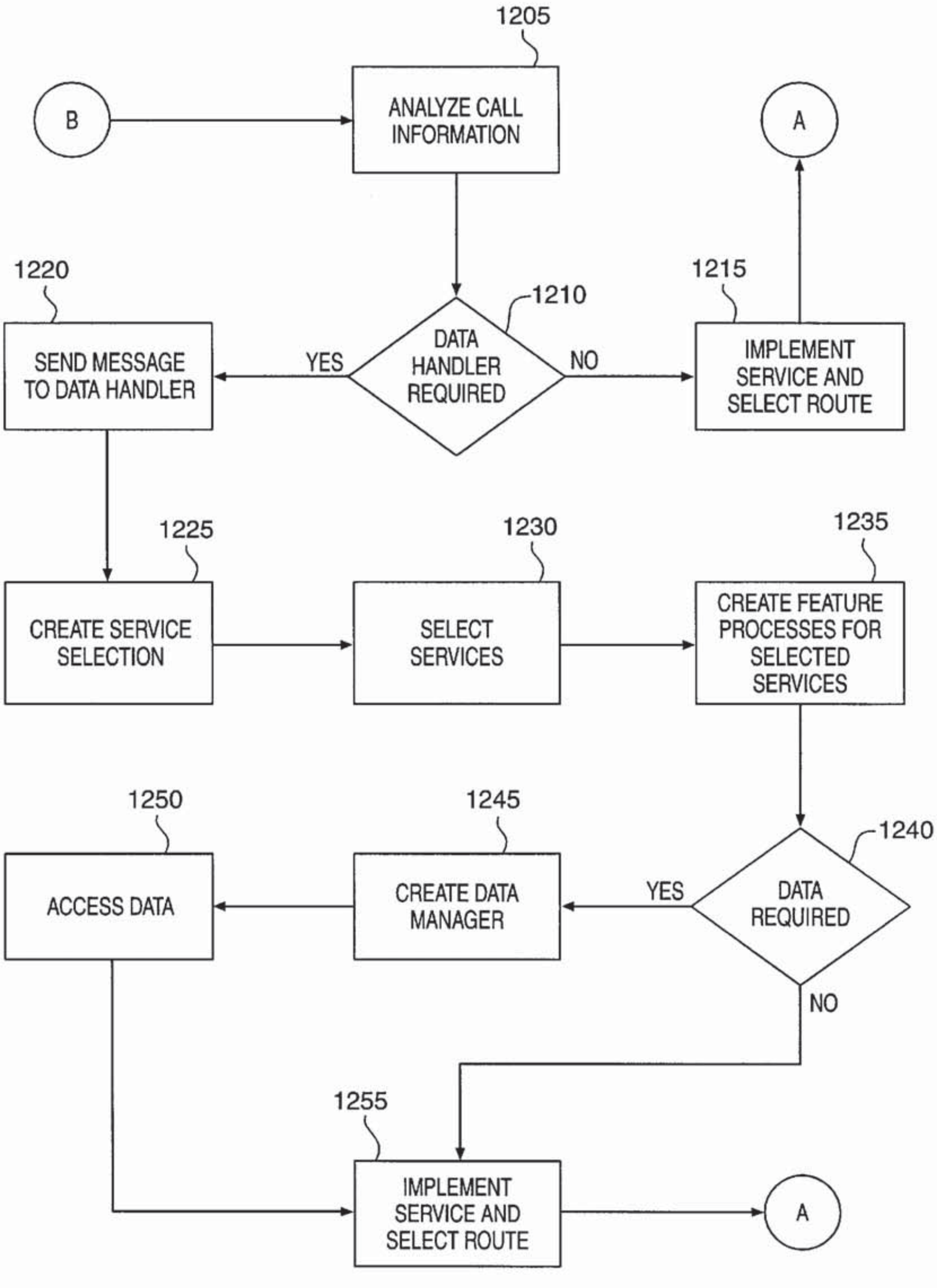

1205
B
ANALYZE CALL INFORMATION
A
1220
1210
1215
SEND MESSAGE TO DATA HANDLER
YES
DATA HANDLER REQUIRED
NO
IMPLEMENT SERVICE AND SELECT ROUTE
1225
1230
1235
CREATE SERVICE SELECTION
SELECT SERVICES
CREATE FEATURE PROCESSES FOR SELECTED SERVICES
1250
1245
1240
ACCESS DATA
CREATE DATA MANAGER
YES
DATA REQUIRED
NO
1255
IMPLEMENT SERVICE AND SELECT ROUTE
A

FIG. 12

BROADBAND TELECOMMUNICATIONS SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of prior application Ser. No. 08/238,605, entitled "Method, System, and Apparatus for Telecommunications Control", filed May 5, 1994, currently pending, and incorporated by reference into this application.

BACKGROUND

At present, Asynchronous Transfer Mode (ATM) technology is being developed to provide broadband switching capability. Some ATM systems have used ATM cross-connects to provide virtual connections. Cross-connect devices do not have the capacity to process signaling. Signaling refers to messages that are used by telecommunications networks to set-up and tear down calls. Thus, ATM cross-connects cannot make connections on a call by call basis. As a result, connections through cross-connect systems must be pre-provisioned. They provide a relatively rigid switching fabric. Due to this limitation, ATM cross-connect systems have been primarily used to provide dedicated connections, such as permanent virtual circuits (PVCs) and permanent virtual paths (PVPs). But, they do not to provide ATM switching on a call by call basis as required to provide switched virtual circuits (SVCs) or switched virtual paths (SVPs). Those skilled in the art are well aware of the efficiencies created by using SVPs and SVCs as opposed to PVCs and PVPs. SVCs and SVPs utilize bandwidth more efficiently.

ATM switches have also been used to provide PVCs and PVPs. Since PVCs and PVPs are not established on a call-by-call basis, the ATM switch does need to use its call processing or signaling capacity. ATM switches require both signaling capability and call processing capability to provide SVCs and SVPs. In order to achieve virtual connection switching on a call by call basis, ATM switches are being developed that can process calls in response to signaling to provide virtual connections for each call. These systems cause problems because they must be very sophisticated to support current networks. These ATM switches must process high volumes of calls and transition legacy services from existing networks. An example would be an ATM switch that can handle large numbers of POTS, 800, and VPN calls. This generation of sophisticated ATM switches is not yet mature and should be expensive when they are first deployed.

Currently, ATM multiplexers are being developed that can interwork traffic into ATM cells and multiplex the cells for transport over an ATM network. One example of an application of these muxes is provided by T1 transport over an ATM connection. Traffic that leaves the switch in T1 format is muxed into ATM cells for transport over a high speed connection. Before the cells reach another switch, they are converted back into the T1 format. Thus, the ATM mux is used for high speed transport. The ATM mux is not used to select virtual connections on a call-by-call basis. Unfortunately, there is not a telecommunications system that can provide ATM switching on a call by call basis without relying on the call processing and signaling capability of an ATM switch.

SUMMARY

The invention includes a method of operating a telecommunications system to provide a call with a virtual connection.

The method is for use when a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection. The system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer. The method comprises receiving the signaling for the call into the signaling processor, processing the signaling to select the virtual connection, generating new signaling to identify the particular connection and the selected virtual connection, and then transmitting the new signaling to the ATM interworking multiplexer. The method also includes receiving the user information for the call from the particular connection into the ATM interworking multiplexer, converting the user information into ATM cells that identify the selected virtual connection in response to the new signaling, and transmitting the ATM cells over the selected virtual connection. The signaling for the call could be a call set-up message, such a Signaling System #7 (SS7) initial address message (IAM). The method could also include applying digital signal processing (DSP) to the call in the multiplexer in accord with DSP requirements selected by the signaling processor. DSP requirements could include echo control or encryption.

The invention also includes a telecommunications system to provide a call with a virtual connection in response to signaling for the call. The system comprises a signaling processor to receive and process signaling to select the virtual connection for the call, and to generate and transmit new signaling that identifies the selected virtual connection. The system includes an ATM interworking multiplexer to receive user information from a connection, convert the user information into ATM cells that identify the selected virtual connection, and transmit the ATM cells over the selected virtual connection. The system could also include an ATM cross-connect system connected to the ATM interworking multiplexer and configured to provide a plurality of virtual connections to the ATM interworking multiplexer.

The invention also includes an ATM interworking multiplexer for providing calls with virtual connections in response to signaling for each of the calls. The multiplexer comprises an access interface to receive user information for each call from a particular connection. It also includes a control interface to receive signaling for each call that identifies the particular connection and a virtual connection for that call. It also includes an ATM adaption processor to convert user information from the particular connection for each call into ATM cells that identify the virtual connection for that call. The multiplexer also includes an ATM interface to transmit the ATM cells for each call over the virtual connection. The multiplexer could include a digital signal processor to apply digital signal processing to the user information for each call. The processing could include echo control and encryption.

In various embodiments, the invention accepts calls placed over DS0 voice connections and provides virtual connections for the calls. In this way, broadband virtual connections can be provided to narrowband traffic on a call-by-call basis without requiring the call processing and signaling capability of an ATM switch.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a version of the present invention.

FIG. **2** is a block diagram of a version of the present invention.

FIG. **3**A and **3**B are block diagram of a versions of the present invention.

FIG. **4** is a block diagram of a version of the present invention.

FIG. **5** is a block diagram of a version of the present invention.

FIG. **6** depicts a logic diagram of a version of the invention.

FIG. **7** depicts a logic diagram of a version of the invention.

FIG. **8** depicts a logic diagram of a version of the invention.

FIG. **9** depicts a logic diagram of a version of the invention.

FIG. **10** depicts a flow diagram of a version of the invention.

FIG. **11** depicts a flow diagram of a version of the invention.

FIG. **12** depicts a flow diagram of a version of the invention.

DETAILED DESCRIPTION

For purposes of clarity, the term "connection" will be used to refer to the transmission media used to carry user traffic. The term "link" will be used to refer to the transmission media used to carry signaling. On the Figures, connections are shown by a single line and signaling links are shown by double lines.

FIG. **1** depicts a version of the present invention. Shown is telecommunications system **100**, user **110**, and user **120**. Telecommunications system **100** includes ATM interworking multiplexer (mux) **130**, mux **140**, ATM cross-connect system **150**, and signaling processing system **160**. User **110** is connected to mux **130** by connection **180**. Mux **130** and mux **140** are connected through cross-connect system **150** by connection **181**. Mux **140** is connected to user **120** by connection **182**. Signaling processing system **160** is linked to user **110** by link **190**, to mux **130** by link **191**, to mux **140** by link **192**, and to user **120** by link **193**.

Those skilled in the art are aware that large networks have many more components than are shown. For example, there would typically be a multitude of virtual connections through ATM cross-connect system **150**. The number of these components has been restricted for clarity. The invention is fully applicable to a large network.

User **110** and user **120** could be any entity that supplies telecommunications traffic to network **100**. Some examples would be a local exchange carrier (LEC) switch or customer premises equipment (CPE). Typically, the user traffic would be provided to system **100** in DS33, DS1, or OC-3 format that have embedded DS0 and VT 1.5 circuits. Connections **180** and **182** represent any connection that might be used by user **120** to access system **100** and would also include formats such as E1, E3, and DS2. As such, these connections are periodically referred to as access connections. Connections **180** and **182** would typically be DS0 connections embedded within a DS3 connection, however, the invention fully contemplates other connection being used with a few examples being a fractional DS1, a clear DS33, or even SONET OC-3. Links **190** and **193** are any links capable of transferring signaling messages with an example being Signaling System #7 (SS7) links. ATM cross-connect system **150** is any system that provides a plurality of virtual connections. Such a system could be comprised of individual ATM cross-connect devices interconnected by ATM connections using DS3 or SONET for transport. An example of an ATM cross-connect is the NEC Model **10**. Connection **181** could be any virtual connection. Typically, the virtual connection would use DS3 or SONET for transport. ATM cross-connect system **150** would be pre-provisioned to provide a plurality of virtual connections through the cross-connect system, and virtual connection **181** represents one of these connections. As virtual connections are logical paths, many physical paths can be used based on the pre-provisioning of ATM cross-connect system **150**. Links **191** and **192** could be any links capable of transporting data messages. Examples of such links could be SS7 or UDP/IP. The components described in this paragraph are known in the art.

Signaling processing system **160** is any processing platform that can receive and process signaling to select virtual connections, and then generate and transmit signaling to identify the selections. Various forms of signaling are contemplated by the invention, including SS7, C7, and user to network interface (UNI) signaling. A preferred embodiment of the signaling processor is discussed in detail toward the end of the disclosure.

Mux **130** could be any muxing system operable to place user information arriving over connection **180** on the virtual connection selected by signaling processing system **160**. Typically, this involves receiving signaling messages from signaling processing system **160** that identify assignments of virtual connections to an access connection on a call by call basis. The mux would convert user traffic from access connection **180** into ATM cells that identify the selected virtual connection. Mux **140** is similar to mux **130**. A preferred embodiment of these muxes are also discussed in detail below.

The system would operate as follows for a call from user **110** to user **120**. User **110** would send a signaling message over link **190** to system **100** initiating the call. Signaling processing system **160** would process the message. Such processing could include validation, screening, translating, route selection, echo control, network management, signaling, and billing. In particular, a virtual connection through ATM cross-connect system **150** from mux **130** to mux **140** would be selected, and a connection from mux **140** to user **120** would also be selected. Although many possible connections would be available, only the selected connections are shown—connection **181** and connection **182**. Generally, the selection is based on the dialed number, but call processing can entail many other factors with a few examples being network loads and user routing instructions. Signaling processing system **160** would then send signaling reflecting the selections to mux **130** and mux **140**.

User **110** would also seize a connection to system **100**. The connection is represented by connection **180** to mux **130**. Although, only one connection is shown for purposes of clarity, numerous connections would typically be available for seizure. The seized connection would be identified in the signaling from user **110** to system **100**. Signaling processing system **160** would include the identity of this connection in its signal to mux **130**.

If required, user **120** would receive signaling to facilitate completion of the call. The signaling from signaling processing system **160** would indicate that system **100** was connecting to user **120** over connection **182**. Typically, user **120** would accept and acknowledge the connection in a signaling message back to system **100**.

Mux **130** would receive signaling from signaling processing system **160** identifying connection **180** as the access

connection and connection **181** as the selected virtual connection through ATM cross-connect system **150**. Mux **130** would convert the user information from connection **180** into ATM cells. Mux **130** would designate connection **181** in the cell headers. Connection **181** would have been previously provisioned through ATM cross-connect system **150** from mux **130** to mux **140**.

Mux **140** would receive signaling from signaling processing system **160** identifying connection **181** as the selected virtual connection and connection **182** as the selected access connection to user **120**. Mux **140** would convert cells arriving on connection **181** to user information suitable for connection **182** to user **120**. Although the above example employs two muxes, a single mux could be employed for calls that enter and exit system **100** through the same mux. In this case, the ATM system would simply provide a virtual connection back to the same mux.

From the above discussion, it can be seen that multiple virtual connections can be pre-provisioned through an ATM cross-connect system to interconnect ATM interworking multiplexers. When a user places a call, one of the virtual connections is selected for the call by the signal processing system and identified to the appropriate muxes. The muxes convert the user information into cells that identify the selected connection. As such, user information can be switched through an ATM fabric on a call by call basis. The system does not require the call processing or signaling capabilities of an ATM switch (although an ATM switch could be used to provide the virtual connections without using its call processing and signaling functions). The system can also implement enhanced services such as N00 and virtual private network (VPN).

FIG. **2** depicts another embodiment of the invention. In this embodiment, the user information from the access connection is capable of being muxed to the DS0 level, but this is not required in other embodiments. Additionally, SS7 signaling is used in this embodiment, but other signaling protocols, such as C7 or UNI signaling, are also applicable to the invention.

Shown are DS0 interface **210**, ATM adaption layer (AAL) **220**, ATM interface **230**, DS0—virtual connection assignment **240**, call/connection manager (CCM) **250** and signal transfer point (STP) **260**. Also shown are connections **280–283** and links **290–292**.

Connection **280** could be any connection or group of connections that contain information that can be converted to DS0 format. Examples of these connections are OC-3, VT1.5, DS3, and DS1. DS0 interface **210** is operable to convert user information in these formats into the DS0 format. AAL **220** comprises both a convergence sublayer and a segmentation and reassembly (SAR) layer. AAL **220** is operational to accept the user information in DS0 format from DS0 interface **210** and convert the information into ATM cells. AALs are known in the art and information about AALs is provided by International Telecommunications Union (ITU) document I.363.1. An AAL for voice is also described in patent application Ser. No. 08/395,745, filed on Feb. 28, 1995, entitled "Cell Processing for Voice Transmission", and hereby incorporated by reference into this application. ATM interface **230** is operational to accept ATM cells and transmit them over connection **283**. Connection **283** is a standard DS3 or SONET connection transporting ATM cells. Connection **281** is operational for the DS0 format and connection **282** is operational to transfer ATM cells.

It can be seen that a communications path through connections **280–283** could be established to carry user information. Although the communications path has been described from connection **280** to connection **283**, the invention contemplates components that are also operational to perform reciprocal processing in the reverse direction. If the communications path is bi-directional, user information in ATM cells arriving on connection **283** would be processed for output on connection **280** in the appropriate format. Those skilled in the art will appreciate that separate connections could also be set up in each direction, or that only a connection in one direction may be required. These components and their operation are known in the art.

Signaling links **290** and **291** are SS7 links. Link **292** is a data link with an example being an ethernet connection transporting UDP/IP. STP **260** is device that routes signaling messages. STPs are well known in the art. CCM **250** would be identified by its own signaling point code. STP **260** would route signaling messages addressed to this point code to CCM **250**. In some embodiments, STP **260** may also convert other point codes to the point code for CCM **250** so these signaling messages are also routed to CCM **250**. Although point code conversion is not essential, it facilitates the transition of a network to the system of the invention. The conversion could be implemented through a conversion table located between level 2 and level 3 of the message transfer part (MTP) function of STP **260**. The conversion table would convert the destination point code of the message to that of CCM **250**, so that the route function of MTP 3 would forward the message to CCM **250**. Point code conversion could be based on many factors with a few examples being the destination point code, the origination point code, the signaling link, the circuit identification code, the message type, and various combinations of these and other factors. For example, SS7 Integrated Services User Part (ISUP) messages with particular OPC/DPC combinations could have the DPC converted to the point code of CCM **250**. These signaling messages would then be routed to CCM **250** by STP **260**. One version of a suitable STP is disclosed in U.S. patent application Ser. No. 08/525,868 entitled "Telecommunications Apparatus, System, and Method with Enhanced Signal Transfer Point", filed simultaneously with this application, assigned to the same entity, and hereby incorporated by reference into this application.

CCM **250** is a signaling processor that operates as discussed above. A preferred embodiment of CCM **250** is provided later. In this embodiment CCM **250** would be operable to receive and process SS7 signaling to select connections, and to generate and transmit signaling identifying the selections.

Assignment **240** is a control interface that accepts messages from CCM **250**. In particular, assignment **240** identifies DS0/virtual connection assignments in the messages from link **292**. These assignments are provided to AAL **220** for implementation. As such, AAL **220** obtains the virtual path identifier (VPI) and virtual channel identifier (VCI) for each call from assignment **240**. AAL **220** also obtains the identity of the DS0 for each call (or the DS0s for an Nx64 call). AAL **220** then converts user information between the identified DS0 and the identified ATM virtual connection. Acknowledgments that the assignments have been implemented may be sent back to CCM **250** if desired.

In operation, calls are processed as follows. Signaling messages for calls arrive on link **290** and are routed by STP **260** to CCM **250**. Access connections are typically seized contemporaneously with the signaling. All of these connections are represented by connection **280**. DS0 interface **210** would convert the traffic on connection **280** into the DS0 format and provide the DS0s to AAL **220** over connection **281**.

The signaling received by CCM **250** would identify the access connections for the calls (i.e. the particular DS0s on connection **280**), and contain call information, such as a dialed number. CCM **250** would process the signaling and select connections for the call. Since multiple virtual connections are pre-provisioned from ATM interface **230** to the other destinations in the network, CCM **250** can select a virtual connection to the destination. The selection process can be accomplished through table look-ups. For example, a table could be used to translate a portion of the dialed number into a VPI. The VCI would be selected based on the available VCIs in the selected VPI. The VPI/VCI combination would correspond to a unique virtual connection pre-provisioned from ATM interface **230** to the appropriate network destination. The selections represent the DS0—virtual connection assignments that are provided to assignment **240** over link **292**.

Assignment **240** accepts the DS0—virtual connection assignments and provides them to AAL **220**. When AAL **220** receives a particular assignment, it converts user information from the designated DS0 into cells that identify the designated VPI/VCI. The cells are provided to ATM interface **230** over connection **282**. ATM interface **230** accepts the cells and places them within the transport format for connection **283**. The cells are then transported over the selected virtual connection to the appropriate destination.

Calls also exit the network through connection **280**. In this case, CCMs at the origination points select the virtual connections to ATM interface **230**. The originating CCMs also send signaling messages to CCM **250**. The signaling messages identify the destinations for the calls and the selected virtual connections. CCM **250** will have a list of available access connections to the identified destinations. CCM **250** will select the access connections to the destination from the list. For example, the connection selected by CCM **250** could be a DS0 embedded within a DS3 connected to a LEC. The virtual connections on connection **283** and selected access connections on connection **280** are provided to assignment **240** over link **292**. Assignment **240** provides these assignments to AAL **220**.

ATM interface **230** will demux the cells arriving from connection **283** and provide them to AAL **220**. AAL **220** converts the user information in the cells into the DS0 format. AAL **220** make the conversion so that cells from a particular virtual connection are provided to the assigned DS0 on connection **281**. DS0 interface will convert the DS0s from connection **281** into the appropriate format, such as DS33, for connection **280**. Those skilled in the art are aware of the techniques for muxing and transporting DS0 signals.

From the above discussion, it can be seen that user information for calls can flow from connection **280** to connection **283**, and in the reverse direction from connection **283** to connection **280**. DS0 interface **210** and ATM interface **230** provide user information in their respective formats to AAL **220**. AAL **220** converts the user information between DS0 and ATM formats based on the assignments from assignment **240**. CCM **250** can select the DS0—virtual connection assignments that drive the process.

The ATM Interworking Multiplexer

FIG. **3**A shows one embodiment of the mux that is suitable for the present invention, but muxes that support the requirements of the invention are also applicable. Shown are control interface **300**, OC-3 interface **305**, DS3 interface **310**, DS1 interface **315**, DS0 interface **320**, digital signal processing(DSP) **325**, AAL **330**, and OC-12 interface **335**.

OC-3 interface **305** accepts the OC-3 format and makes the conversion to DS33. DS3 interface **310** accepts the DS3 format and makes the conversion to DS1. DS3 interface **310** can accept DS3s from OC-3 interface **305** or from an external connection. DS1 interface **315** accepts the DS1 format and makes the conversion to DS0. DS1 interface **315** can accept DS1s from DS3 interface **310** or from an external connection. DS0 interface **320** accepts the DS0 format and provides an interface to digital signal processing (DSP) **325**.

DS0 interface **320** is coupled to DSP **325**. DSP **325** is capable of manipulating the user information to improve transmission quality. DSP processing primarily entails echo cancellation, but could include other features as well. As is known, echo cancellation can be required for voice calls. DSP **325** passes the DS0s through echo cancellers. These echo cancellers must be disabled for calls that do not require echo control. Data calls do not require echo cancellation, and the CCM has the ability to recognize data calls that require an echo canceller to be disabled. The CCM will send a control message through control interface **300** to DSP **325** indicating the particular echo canceller that is to be disabled. The CCM selects the echo canceller based on the CIC in the signaling it receives from the user. After the data call, the CCM sends a message that causes the particular echo canceller to be enabled again for subsequent voice calls. The above technique of applying echo control is preferred, but other means of implementing echo control instructions from the CCM are also applicable.

In addition to echo control, the CCM and the mux can work to provide other digital signal processing features on a call by call basis. Compression algorithms can be applied, either universally, or on a per call basis. The decibel level could be adjusted for calls form a particular origin or to a particular destination, i.e. where a hearing impaired person may reside. Encryption could be applied on a call-by-call basis based on various criteria like the origination number or the destination number. Various DSP features could be associated with various call parameters and implemented by the CCM through DSP **325**.

DSP **325** is connected to AAL **330**. AAL **330** operates as described above for an AAL. DS0—virtual connection assignments from control interface **300** are implemented by AAL **330** when converting between the DS0 and ATM formats.

Calls with a bit rate greater than 64 kbit/sec. are known as Nx64 calls. If desired, AAL **330** can be capable of accepting control messages through control interface **300** from the CCM for Nx64 calls. The CCM would instruct AAL **330** to group the DS0s for the call.

FIG. **3**B shows another version of the multiplexer for other embodiments. The multiplexer is similar to FIG. **3**A except that E3 interface **312**, E1 interface **317**, and OC-3 interface **337** are shown.

The ATM Cross-connect System

FIG. **4** depicts virtual connections provided by the ATM cross connect system in a version of the invention, although numerous other techniques for providing virtual connections will be appreciated by one skilled in the art, and the invention contemplates any such system. Shown are virtual connections **410**, **412**, **414**, **416**, **418**, and **420**. These virtual connections are shown interconnecting muxes A, B, and C through cross-connects Y and Z. Virtual connections are provisioned in between each mux. Each mux would have a virtual path to the cross-connect system that is designated for each possible destination mux. Virtual path AB contains

virtual connection **412** from mux A to mux B. For calls that originate and terminate at the same mux, virtual connections **410**, **416**, and **420** are provisioned for that purpose. Virtual connections **414** and **418** connect muxes A/C and B/C respectively. Alternate routes for different virtual connections can be provisioned between the same two muxes.

Within each virtual path are thousands of virtual channels (not shown). Virtual connections are provisioned by cross-connecting VPI/VCI combinations at cross-connects Y and Z. If a call enters mux A and needs to terminate at mux B, the CCM will select virtual path AB. The selection could be based on a translation of the dialed number. Within virtual path AB, the CCM would select the particular virtual channel. This selection could be based on available VCIs within the VPI. In this way, pre-provisioned virtual connections can be selected on a call by call basis.

Typically, calls will require a bi-directional voice connection. For this purpose, a virtual connection must transport user information in both directions. The virtual connections can be provisioned so that the mux at the terminating end may use the same VPI/VCI for cells transported in the opposite direction. The terminating CCM could also translate the originating VPI/VCI into another VPI/VCI provisioned in the opposite direction and provide this VPI/VCI to the terminating mux.

Additionally, the number of active virtual connections in between cross-connects can be tracked. Virtual path YZ connects cross-connects Y and Z. The capacity of virtual path YZ would be sized based on network requirements, but should it become overloaded, the CCMs can be programmed to select an alternate virtual path.

Operation within a Network

FIG. **5** depicts an embodiment of the invention with respect to a specific telecommunications network scenario, although the invention is not limited to this specific scenario. FIG. **5** shows telecommunications system **500**. Shown are user **510**, user **512**, user **514**, user **516**, STP **518**, STP **520**, STP **522**, STP **524**, mux **526**, mux **528**, mux **530**, mux **532**, call/connection manager (CCM) **534**, CCM **536**, CCM **538**, CCM **540**, ATM cross-connect **542**, ATM cross-connect **544**, and ATM cross-connect **546**. For clarity, the connections and signaling links are not numbered. All of these components are described, and the CCMs are also discussed below.

In operation, user **510** may forward an 800 call to system **500**. User **510** could be connected to mux **526** with a DS3 connection. The 800 call would occupy a DS0 embedded in the DS3 connected to mux **526**. User **510** would send an SS7 Initial Address Message (IAM) through STP **518** to system **500**. STP **520** would be configured to route the IAM to CCM **534**. An IAM contains information such as the dialed number, the caller's number, and the circuit identification code (CIC). The CIC identifies the DS0 used by user **510** for the call.

CCM **534** would process the IAM and identify that the call was an 800 call. Either through its own database or by accessing a service control point (SCP) (not shown), the CCM would translate the dialed number based on the 800 subscriber's routing plan. For example, 800 calls from user **510** may be routed to user **512** during business hours, to user **514** at night, and to user **516** on weekends. If the call is placed from user **512** on a weekend, the call would be routed to user **516**. As such, CCM **534** would select a pre-provisioned virtual connection from mux **526** through ATM cross-connect **542** and ATM cross-connect **544** to mux **530**. CCM **534** would send an IAM message to CCM **538** through STP **520** and STP **522**. The IAM would indicate that a call was being routed to user **516** and would identify the selected virtual connection being used to reach mux **530**.

Typically, mux **530** would be connected to user **516** with a DS3 connection. CCM **538** would select a DS0 embedded in the DS3 and would send an IAM to user **516** through STP **522** and STP **524**. The CIC of the IAM would indicate that a call was being routed to user **516** over the selected DS0. User **516** would process the IAM and complete the call. When the call is answered, user **516** would transmit an answer message (ANM) through STP **524** back to system **500**.

CCM **534** would also send a UDP/IP message to mux **526** instructing it to assemble the user information in the DS0 from user **510** into ATM cells with a cell header identifying the selected virtual connection. CCM **538** would send a UDP/IP message to mux **530** instructing it to dis-assemble ATM cells from the selected virtual connection and output the user information to the selected DS0 to user **516**. ATM cross-connect **542** would route ATM cells from mux **526** to ATM cross-connect **544** based on the cell header. Likewise, ATM cross-connect **544** would route these cells to mux **530** based on the cell header. As such, user information for the call would flow from user **510** to user **516** over the DS0 from user **510**, the virtual connection selected by CCM **534**, and the DS0 to user **516** selected by CCM **538**. The muxes would implement the selections of the CCMs.

The call would require that a voice channel be available in both directions. As such, the DS0s and virtual connection would be bi-directional. Cut-through on the receive channel (from the user **516** to the user **510**) would occur after the address complete message (ACM) had been received by system **500**. Cut-through on the transmit channel (from the user **510** to the user **516**) would occur after the answer message (ANM) had been received by system **500**. This could be accomplished by not allowing mux **530** to release any cells for the call until the ANM has been received by system **500**.

If user **510** were to place the call at night, CCM **534** would determine that user **514** was the destination. Accordingly a pre-provisioned virtual connection from mux **526** through ATM cross-connect **542** and ATM cross-connect **546** to mux **528** would be selected for the call. CCM **536** would select the DS0 to user **514**.

If user **510** were to place the call during the day, CCM **534** would determine that user **512** was the destination. Accordingly a pre-provisioned virtual connection from mux **526** through ATM cross-connect **542** and back to mux **526** would be selected for the call. CCM **534** would also select the DS0 to user **512**.

Application number 08/568,551, entitled "Method, System, and Apparatus for Telecommunications Control," filed on Dec. 7, 1995 and currently pending (and which is a continuation of Application number 08/238,605, filed on May 5, 1994, and now abandoned) is incorporated by reference into this application.

The Call/Connection Manager (CCM)

FIGS. **6–12** refer to a preferred embodiment of the signaling processor, also known as the CCM, but any processor which supports the requirements stated for the invention would suffice. FIG. **6** depicts a signaling processor suitable for the invention. Signaling processor **610** would typically be separate from the mux, but those skilled in the art appreciate that they could be housed together. Also, signaling processor may support a single mux or support multiple muxes.

Signaling processor **610** includes Message Transfer Part (MTP) level 1 **612**, MTP level 2 **615**, and MTP level 3 **620**. MTP level 1 **612** defines the physical and electrical requirements for a signaling link. MTP level 2 **615** sits on top of level 1 and maintains reliable transport over a signaling link by monitoring status and performing error checks. Together, MTP levels 1-2 provide reliable transport over an individual link. A device would need MTP level 1-2 functionality for each link it uses. MTP level 3 **620** sits on top of level 2 and provides a routing and management function for the signaling system at large. MTP level 3 **620** directs messages to the proper signaling link (actually to the MTP level 2 for that link). MTP level 3 **620** directs messages to applications using the MTP levels for access the signaling system. MTP level 3 **620** also has a management function which monitors the status of the signaling system and can take appropriate measures to restore service through the system. MTP levels 1–3 correspond to layers **1-3** of the open systems interconnection basic reference model (OSIBRF). Both the MTP 1–3 and the OSIBRF are well known in the art

Also shown for signaling processor **610** are ethernet interface **635**, platform handler **640**, message handler **645**, and data handler **650**. Ethernet interface **635** is a standard ethernet bus supporting TCP/IP which transfers signaling messages from MTP level 3 to platform handler **640**. Also, if UDP/IP is used to communicate with the muxes, ethernet interface **335** would accept the links to the muxes. Those skilled in the art will recognize other interfaces and protocols which could support these functions in accord with the invention.

In accord with this invention, the logic of the signaling interface (indicated by reference numerals **612**, **615**, **620**, and **635**) would be operational to route select ISUP messages to platform handler **640**. Technique for doing this have been discussed above. Preferably, an SS7 interface to platform handler **640** could be constructed using commercially available SS7 software interface tools. An example of such tools would be SS7 interface software provided by Trillium, Inc.

Platform handler **640** is a system which accepts ISUP and B-ISUP messages from ethernet interface **635** and routes them to message handler **645**. Preferably, platform handler **640** is configured to route messages to a particular message handler processor based on the signaling link selection (SLS) code in the message. Message handler **645** is a system which exchanges signaling with platform handler **640** and controls the connection and switching requirements for the calls. It can select and implement services and initiate echo control. It also converts signaling between ISUP and B-ISUP. Data handler **650** is a set of logic coupled to message handler **645** which processes service requests and provides data to message handler **645**. Data handler **650** also controls echo cancellers and generates billing records for the call.

In the discussions that follow, the term ISUP will include B-ISUP as well. In operation, ISUP messages that meet the proper criteria are routed by MTP and/or ATM interface **615**, MTP level 3 **620**, and ethernet interface **635** to platform handler **640**. Platform handler **640** would route the ISUP messages to message handler **645**. Message handler **645** would process the ISUP information. This might include validation, screening, and determining if additional data is needed for call processing. If so, data handler **650** would be invoked and would provide message handler **645** with the relevant data so message handler **645** could complete call processing. Message handler **645** would generate the appropriate ISUP message to implement the call and pass the signals to platform handler **640** for subsequent transmission to the designated network elements.

The distribution of functional entities among message handler **645** and data handler **650** are shown. These functional entities are well known in the art. Message handler **645** includes at least the call control function (CCF) and the service switching function (SSF). The CCF establishes and releases call connections, and the SSF recognizes triggers during call processing by the CCF and provides an interface between the CCF and the service control function (SCF). The SCF identifies services and obtains data for the service. In some embodiments, message handler **645** can include the SCF and the service data function (SDF). The SDF provides service data in real time to the SCF. Taken together, message handler **645** is able to at least control connections and recognize triggers. In some embodiments, message handler **645** can also identify services, obtain data for the services, and generate the signaling required to implement the services. Message handler **645** can provide signaling interworking (i.e. ISUP to B-ISUP), connection control, service selection and service implementation in a logically integrated package that interfaces with the network through conventional means.

Data handler **650** includes at least the SCF and the SDF. In some embodiments, message handler **645** and data handler **650** both include the SCF and the SDF and services are partitioned among the functional entities. Two other functions are shown in data handler that are not standardized functional entities. Accounting generates a billing record and echo handles the echo cancellers. Typically, an echo canceller is disabled for a data call and enabled after the data call for use on subsequent voice calls, however, other techniques are applicable.

In operation, the CCF would perform basic call processing until the SSF recognized a trigger and invoked the SCF. The SCF would identify the service associated with the trigger. The SCF would access data from the SDF in order to implement the service. The SCF would process the data from the SDF and provide the data to the CCF through the SSF. The CCF would then set-up the connections through conventional signaling to service switching points (SSPs). The SSPs are connected to the communications path and make the connections. Typically, an SSP is a switch. Also, echo cancellers may be controlled for the call, and a billing record could be generated for the call.

Those skilled in the art are aware of various hardware components which can support the requirements of the invention. For example, the platform handler, message handler, and data handler could each reside on a separate SPARC station **20**.

The Platform Handler

FIG. **7** shows a possible version of the platform handler. Platform handler **710** is shown. Platform handler **710** includes STP handler **712**, supervisor **714**, and CCM handler **716**. Platform handler **710** transmits and receives ISUP messages to/from the signaling interface (reference numerals **312**, **315**, **320**, and **335**). STP handler **712** would provide the ethernet—TCP/IP interface. STP handler **712** has a process to buffer and dis-assemble the incoming packets to the CCM, and buffer and assemble outgoing packets. STP handler **712** could also check the messages for basic flaws. Any technique for transfer of signaling messages to platform handler **710** is contemplated by the invention.

Supervisor **714** is responsible for managing and monitoring CCM activities. Among these are CCM start-up and

shut-down, log-in and log-off of various CCM modules, handling administrative messages (i.e. error, warning, status, etc.) from the CCM modules, and handling messages from network operations such as queries, configuration instructions, and data updates. The connection to network operations is the man machine interface which allows the CCM to be controlled and monitored by either a remote or a local operator. Supervisor **714** has a process which retrieves configuration data from internal tables to initialize and configure the CCM. The CCM modules also have internal tables which are used in conjunction with this procedure. Supervisor **714** also communicates internally with STP handler **712** and CCM handler **716**.

CCM handler **716** exchanges ISUP information with STP handler **712**. CCM handler **716** also exchanges ISUP messages and CCM supervisory messages with the message handler. The connection between CCM handler **716** and the message handler could be an ethernet LAN transporting these messages encapsulated in TCP/IP packets, but other methods are known. CCM handler **716** would provide the ethernet—TCP/IP interface. CCM handler **716** has a process to buffer and dis-assemble the incoming packets from the message handler, and buffer and assemble outgoing packets to the message handler. CCM handler **716** could also check the messages for basic flaws.

Internally, platform handler **710** is equipped with bi-directional channels which exchange information among STP handler **712**, supervisor **714**, and CCM handler **716**. The channels between STP handler **712**, CCM handler **715**, and supervisor **712** carry supervisory and administrative information. The channel between STP handler **712** and CCM handler **716** carries ISUP message information.

Platform handler **710** accepts, disassembles, and buffers ISUP messages received from the network. It can perform basic checks on the messages before transferring them to the message handler. Should more than one message handler be connected to platform handler **710**, the ISUP messages could be allocated to the message handlers based on the SLS of the particular ISUP message. CCM handler **716** accepts routing instructions from the message handler for routing certain ISUP messages to select processes of the message handler. Platform handler **710** also provides supervision and a man/machine interface for the CCM.

The Message Handler.

FIG. **8** depicts a version of the message handler. Message handler **820** is shown and includes call center **821**, origination manager **822**, termination manager **823**, detection point manager **828**, feature manager **824**, auxiliary manager **825**, switching manager **826**, and local resource **827**. A primary function of message handler **820** is to process ISUP messages.

Call center **821** is the process which receives call set-up messages from the platform handler. ISUP call set-up is initiated with the IAM. When call center **821** receives an IAM, it creates an instance of an origination manager process with data defined by the information in the IAM. Origination manager **822** represents any of the origination manager processes spawned by call center **821**. The CCM handler is instructed of the new instance so that subsequent ISUP messages related to that call can be transferred directly to the appropriate instance of origination manager **822** by the platform handler.

Origination manager **822** sets up a memory block called an originating call control block. The call control block provides a repository for information specific to a call. For example, the originating call control block could identify the following: the call control block, the origination manager, the message handler, the originating LEC, the LEC trunk circuit (CIC), the ATM virtual circuit, the ATM virtual path, the caller's number, the dialed number, the translated dialed number, the originating line information, the ANI service class, the selected route, the number of the selected route, the SLS, the OPC, the DPC, the service indicator (SIO), echo cancellation status, reason of release, call status, and pointers to adjacent call control blocks. In addition, the call control block would also contain the various times that signaling messages are received, such the address complete message (ACM), the answer message (ANM), the suspend message (SUS), the resume message (RES), and the release message (REL). Those skilled in the art would be aware of other pertinent data to include.

Origination manager **822** executes call processing in accordance with the Basic Call State Model (BCSM) recommended by the International Telecommunications Union (ITU), but with some notable exceptions. Origination manager **822** processes the IAM through each point in call (PIC) until a detection point (DP) is encountered. When a detection point is encountered, a message is sent to detection point manager **828** and processing is suspended at origination manager **822** until detection point manager **828** responds. An example of a detection point for origination manager **822** would be to authorize an origination attempt.

Detection point manager **828** accepts messages from originating manager **822** caused by a detection point encountered during call processing. Detection point manager **828** will identify whether or not the detection point is armed. An armed detection point has specific criteria which can affect call processing if met. If the detection point is not armed, detection point manager **828** will send a continue signal back to origination manager **822**. A continue message instructs origination manager **822** to continue call processing to the next detection point. If the detection point is armed, detection point manager **828** will take action to see if the detection point criteria are met. If detection point manager **828** requires assistance to process the armed detection point, it will send a message to feature manager **824**.

Feature manager **824** would accept messages from detection point manager **828** and either forward the a message to auxiliary manager **825** or to switching manager **826**. Particular feature messages would be routed to auxiliary manager **825** which will process these call features. These are typically non-IN features, such as echo control or POTS billing. Other feature messages would be routed to switching manager **826**. These are typically IN features. Examples of IN features are 800 number translation or a terminal mobility number translation. Feature manager **824** will pass information back to detection point manager **828** (then to origination manager **822**) when it is received back from auxiliary manager **825** or switching manager **826**.

Switching manager **826** which will determine if the request will be handled by local resource **827** or by the data handler. Local resource **827** will be structured to provide data more efficiently stored at message handler **820**. Examples of such data include: an automatic number identification (ANI) validation table which checks the caller's number, a dialed number translation table to translate POTS numbers into a routing instructions, or N00 translation tables to translate select 800 numbers into routing instructions. Examples of a routing instruction yielded by the tables would be a particular access connection or a virtual connection. An example of data in the data handler would be virtual private network (VPN) routing tables or complex 800 routing plans.

Typically, originating manager **822** will execute through the pertinent points in call to a point indicating that set up is authorized. At this point, origination manager **822** will instruct call center **821** to create an instance of a termination manager. Termination manager **823** represents any of these termination managers. Origination manager **822** will also transfer IAM information to termination manager **823**. Termination manager **823** sets up a memory block called a terminating call control block. The call control block provides a repository for information specific to a call and is similar in composition to the originating call control block.

Termination manager **823** also operates in accord with the BCSM of the ITU, but also with some exceptions. Termination manager **823** continues processing for the call through its own points in call until detection points are encountered. When a detection point is encountered, a message is sent to detection point manager **828** and processing is suspended at termination manager **823** until detection point manager **828** responds. An example of detection point for termination manager **822** would be to authorize termination which would entail authorizing the call as set-up by origination manager **822**. Messages from termination manager **823** to detection point manager **828** are handled as discussed above for messages from originating manager **822**. When processing by termination manager **823** is complete, it will produce a signaling message to transmit through platform handler **410** to the appropriate multiplexers, and possibly to the users.

Message handler **820** communicates with the data handler using a data transfer protocol. Examples include UDP/IP, or the Intelligent Network Applications Protocol (INAP) which is contained within the component sublayer of Transaction Capabilities Application Part (TCAP).

The Data Handler

FIG. **9** shows a version of the data handler. Data handler **930** is shown. Data handler **930** includes service control center **931**, service selection **932**, service logic center **933**, feature process **934**, service data center **935**, service data manager **936**, echo control **937**, and accounting **938**. Data handler **930** receives service request messages from the message handler. These messages result from an armed detection points triggering the message handler to invoke data handler **930**. The messages also result from features implemented through the auxiliary manager. Service control center **931**, service logic center **933**, and service data center **935** are static processes created at start-up. Service control center **931** creates instances of service selection managers on a call by call basis. Service control center **931** notifies the Switching manager to route subsequent service request messages for that call to the appropriate service selection manager. Service selection manager **932** represents any of the service selection managers created by service control center **931**.

Service selection manager **932** executes the service portion of the call processing. Service selection manager **932** identifies the various services associated with each message and implements the service through messages to service logic center **933**. Service logic center **933** accepts messages from service selection **932** and creates instances of the feature processes required for the identified services. Examples of feature processes are N00, messaging, personal/terminal mobility, and virtual private network (VPN). Feature processes are service logic programs which implement the required services for a call. Feature process **934** represents any of the feature processes created by service logic center **933**. Feature process **934** accesses the network resources and data required to implement the service. This would entail executing service independent blocks (SIBs). A SIB is a set of functions. An example of a function would be to retrieve the called number from a signaling message. SIBs are combined to build a service. An example of a SIB is translating a called number.

Those skilled in the art are familiar with the above services, although they have never been implemented by a system such as the present invention. N00 services are services such as 800, 900, or 500 calling in which the dialed number is used to access call processing and billing logic defined by the subscriber to the service. Messaging entails connecting the caller to a voice messaging service. For example, the receipt of a release message (REL) with a cause of busy could be a trigger recognized by the message handler. In response, the data handler would create an instance of the messaging feature process and determined if a call placed to a particular dialed number would require the voice messaging platform. If so, the CCM would instruct an SSP to connect the caller to the voice message platform. Personal/Terminal mobility includes recognizing that the dialed number has mobility that requires a database look-up to determine the current number. The database is updated when the called party changes locations. VPN is a private dialing plan. It is used for calls from particular dedicated lines, from particular calling numbers (ANIs), or to particular dialed numbers. Calls are routed as defined for the particular plan.

In the execution of the SIB to provide the service, feature process **934** would invoke service data center **935** to create an instance of service data manager **936**. Service data manager **936** accesses the network databases that provide the data required for the service. Access could be facilitated by TCAP messaging to an SCP. Service data manager **936** represents any of the service managers created by service data center **935**. Once the data is retrieved, it is transferred back down to feature process **934** for further service implementation. When the feature processes for a call finish execution, service information is passed back down to the message handler and ultimately to the origination or termination manager for the call.

After a release message on a call, billing requests will be forwarded to accounting **938**. Accounting **938** will use the call control block to create a billing record. The call control block would contain information from the ISUP messages for the call and from CCM processing. From the address complete message (ACM), the call control block would include the routing label, CIC, message type, and cause indicators. From the answer message (ANM), the call control block would include the routing label, CIC, message type, and backward call indicators. From the initial address message (IAM), the call control block would include the routing label, CIC, message type, forward call indicators, user service information, called party number, calling party number, carrier identification, carrier selection information, charge number, generic address, origination line information, original called number, and redirecting number. From the release message (REL), the call control block would include the routing label, CIC, message type, and cause indicators. From the suspend message (SUS) or the pass along message (PAM), the call control block would include the routing label, CIC, and message type. Those skilled in the art are familiar with other pertinent information for a billing record and appreciate that some of this information could be deleted.

For POTS calls, the billing request will come from the origination and termination managers through the auxiliary

manager. For IN calls, the request will come from service selection **932**. Accounting **938** will generate a billing record from the call control blocks. The billing record will be forwarded to a billing system over a billing interface. An example of such an interface is the I.E.E.E. 802.3 FTAM protocol.

At some point during call set-up, the origination manager, termination manager or even the detection point process will check the user service information data and originating line information to assess the need for echo control. If the call is a data call, a message is sent to data handler **930**. Specifically, the message is routed through the auxiliary manager to the echo control manager **937** in data handler **930**. Based on the CIC, echo control manager **937** can select which echo canceller and DS0 circuit needs to be disabled. A message will be generated to that effect and transmitted over a standard data link to the pertinent echo canceller or echo control system. As described above, echo control can be implemented by the multiplexer. Once a release (REL) message is received for the call, the echo canceller is re-enabled. On a typical call, this procedure will occur twice. Once for an echo canceller on the access side, and again for an echo canceller on the terminating side. The CCM that handles the IAM for a particular call segment will control the particular echo cancellers for the segment.

IAM Call Processing

Prior to a description of IAM processing, a brief description of SS7 message is given. SS7 messaging is well known in the art. SS7 ISUP messages contain numerous fields of information. Each message will have a routing label containing a destination point code (DPC), an origination point code (OPC), and a signaling link selection (SLS) which are used primarily for routing the message. Each message contains a circuit identification code (CIC) which identifies the circuit to which the message relates. Each message contains the message type which is used to recognize the message. ISUP messages also contain mandatory parts filled with fixed length data and variable length data, in addition to a part available for optional data. These parts vary from message type to message type depending on the information needed.

The initial address message (IAM) initiates the call and contains call set-up information, such as the dialed number. IAMs are transferred in the calling direction to set up the call. During this process, TCAP messages may be sent to access remote data and processing. When the IAMs have reached the final network element, an address complete message (ACM) is sent in the backward direction to indicate that the required information is available and the called party can be alerted. If the called party answers, an answer message (ANM) is sent in the backward direction indicating that the call/connection will be used. If the calling party hangs up, a release message (REL) is sent to indicate the connection is not being used and and can be torn down. If the called party hangs up, a suspend reconnects, a resume (RES) message keeps the line open, but if their is no re-connection, a release message (REL) is sent. When the connections are free, release complete messages (RLC) are sent to indicate that the connection can be re-used for another call. Those skilled in the art are aware of other ISUP messages, however, these are the primary ones to be considered. As can be seen, the IAM is the message that sets-up the call.

In the preferred embodiment, call processing deviates from the basic call model recommended by the ITU, although strict adherence to the model could be achieved in other embodiments. FIGS. **10–12** depicts the preferred call processing. Referring first to FIG. **10**, When the IAM for a call is received at **1005**, the call center creates an instance of an origination manager at **1010**.

The origination manager begins call processing by sending an authorize message to the detection point manager. Detection point manager checks IAM information, including the dialed number, the CIC, and the originating line information, to perform service discrimination at **1015**. This is done to determine if the service requested requires validation at **1020**. Current call processing systems and the BCSM of the ITU both validate the call before performing service discrimination. In a significant advance over the prior art, the preferred embodiment deviates from known call processing methods by looking at the IAM information prior to validation to determine if validation is even required. For example, the calling party may not pay the bill for a call. The called party pays the bill on 800 calls and validation can be unnecessary. If validation is not required at **1020**, call processing proceeds directly to B. Advantageously, this avoids unnecessary look-ups in validation tables for a significant percentage of calls.

If validation is required at **1020**, a validation table is checked at **1025**. Validation checks to see if a call should be allowed and focuses on potential billing problems for the call. For example, calls from ANIs that are delinquent on payments pose problems for billing and may not be validated. Validation would entail messaging from the detection point manager through the feature manager and the switching manager to the local resource to access the tables. The table may list authorized ANIs, unauthorized ANIs, or both. If the call is not authorized at **1030**, treatment (i.e. route to an operator or message) is given to the call at **1035**.

If the call is authorized at **1030**, the services identified at **1015** are checked at **1040** to determine if the call can be routed. This would typically occur for POTS calls. If no additional services are required at **1040**, the dialed number is translated into a route instruction at **1045**. The route instruction could be a particular virtual connection and/or access connections. The processing then proceeds to A. If additional services are required at **1040**, processing proceeds to B.

FIG. **11** picks up processing at A after a route has been selected. A termination manager is created at **1105**. The termination manager is responsible for processing in accordance with the terminating BCSM of the ITU. However, in some embodiments, the processing can exhibit some deviation. For example, detection points such as select facility and validate call may be skipped.

The bearer capability is analyzed at **1110** to determine if the call is a data call at **1115**. This analysis could occur elsewhere in the call processing (i.e by the origination manager after the route is selected.) If a data call is found at **1115**, an echo control message is sent to the data handler at **1120**. Echo control instructions are created at **1125**. The echo control instructions identify the connection for the call which requires echo control. The message could be sent to the echo control system over a conventional data link from the CCM to the echo control system. If, the echo control is implemented in the multiplexers, the echo control message could be included with the route instruction message.

If the call is not a data call at **1115** or after echo control processing at **1125**, a signaling message is created at **1135**. The new signaling message identifies the access connections and virtual connection for the call. The new signaling

message can also contain echo control instructions. The new signaling message is sent to the platform handler at **1140**.

FIG. **12** picks up the processing at B. At this point, several things are known about the call concerning authorization and service requirements. The call information is then analyzed at **1205** as required to apply services to the call. If the data handler is not required at **1210**, the service is implemented and the route is selected at **1215**. This may occur if a service can be directly implemented by the origination manager or through the local resource. For example, particular 800 translations or dialed number service profiles (i.e call forwarding) can be stored in the local resource. In this case, route selection would be performed by the local resource after the information is analyzed to identify the correct entry to a local resource database. When the local resource is used, the messages must be routed from the detection point processor through the feature manager and switching manager to the local resource.

If the data handler is required for the call at **1210**, a message is sent to the data handler at **1220**. The messaging typically flows from the detection point processor to the feature manager and switching manager to the data handler. Upon receipt of the message at the data handler, the service control center creates an instance of the service selection process at **1225**. The service selection process analyzes the message from the detection point processor and selects the feature processes for the call at **1230**. For example, a call may be placed from a caller in a virtual private network (VPN) to a PCS number. In this case, both a VPN feature process and a PCS feature process would be created.

Each feature process would determine if data was required at **1240**. For example, a personal mobility feature process would need to access a database to locate the called party's current telephone number. If data is required at **1240**, the service data center creates a service data manager at **1245**. The data manager manages the data session and accesses the appropriate database at **1250**. After the data is collected (or none is needed), the service is implemented by the feature process at **1255**. For some features, i.e. 800 service, this may include route selection. The results of the feature process analysis are returned to the origination manager to assimilate. If the feature process does not provide the route, the origination manager must select the route using the local resource or another feature process.

The IAM itself contains numerous fields of information. The following table describes the elements of an IAM with regard to the information content and call processing.

TABLE 1

Initial Address Message

Parameter Field Name	Description
ROUTING LABEL	
Service Indicator	Set at 0101-ISDN user part
Priority	0 or 1 based on destination
Network ID	10 for national network or set based on international trunk group
Destination Point Code	Destination of IAM
Originating Point Code	Origination of IAM
Signaling Link Connection	Link used for messages (same for all messages for the call)
Circuit ID Code	Circuit used for the call between OPC and DPC in the IAM
Message Type	0000 or 0001 for IAM

TABLE 1-continued

Initial Address Message

Parameter Field Name	Description
NATURE OF CONNECTION INDICATORS	
Satellite Indicator	Increment for each satellite used
Continuity Check Indicator	00 - no check 01 - set up check and start COT timer 10 - start timer for COT message.
Echo Suppresser Indicator	Indicates if echo control already implemented or is set if echo control is implemented
FORWARD CALL INDICATORS	
National/International Call Indicator	0 for domestic 1 for international
End to End Method Indicator	Pass any information
Interworking Indicator	Pass any information
IAM Segmentation Indicator	0 for POTS
ISDN User Part Indicator	Pass any information
ISDN Preference Indicator	Pass any information and default to 00
ISDN Access Indicator	Pass any information
SCCP Method Indicator	00
CALLING PARTIES CATEGORY	
Calling Party Category	00000000 for unknown 00001010 for ordinary caller 00001101 for test call
USER SERVICE INFORMATION	
Information Transfer Capability	Pass any information unless destination requires particular settings, but always pass ISDN "unrestricted digital information"
Coding Standard	00
Extension	1
Information Transfer Rate	Pass any information (will be 10000 for POTS)
Transfer Mode	Set at 00 for 64 kbit/sec
Extension	1
User Layer Protocol Identification	Set based on rate adaption, typically 0100010 for user information layer 1
Extension	1 for normal calls 0 for rate adaption
Rate	Nothing for user information layer 1, but 0111 for other rate adaption
Extension	1
CALLED PARTY NUMBER	
Nature of Address Indicator	Identifies the type of call: 0000001 - original NPA or 950 call 0000011 - 1 + call 0000100 - direct dial international call 1110001 - operator call 1110010 - operator default 1110011 - international operator call 1110100 - long distance operator call 1110101 - cut through call 1110110 - 950, hotel/motel, or non equal access call 1110111 - test call
Odd/Even	number of digits in a called number
Numbering Plan	000 - default 001 - for ISDN 101 - private
Digits Field	number of the called party
ACCESS TRANSPORT	
Access Transport Elements	pass any information

TABLE 1-continued

Initial Address Message

Parameter Field Name	Description
CALLING PARTY NUMBER	
Nature of Address Indicator	Indicates the type of calling party address, unique numbers can be used for billing, but the charge number is used for non-unique numbers: 0000000 - unknown 0000001 - unique caller number 0000011 - unique national number 0000100 - unique international number 1110001 - non-unique caller number 1110011 - non-unique national number 1110100 - non-unique international number 1110111 - test call
Odd/Even	Number of digits in the calling number
Screening	Not applicable
Presentation Allowed/Restricted	Pass any information for POTS, but restrict for N00 calls that are not allowed
Numbering Plan	000 - default 001 - ISDN 101 - private
Digits Field	Number of the calling party
CARRIER IDENTIFICATION	
Network Identification Plan	Number of digits in identification code for the requested carrier
Type of Network Identification	Identifies the network numbering plan for the call - 010 for POTS call from LEC
Digit One	First digit in carrier identification code
Digit Two	Second digit in carrier identification code
Digit Three	Third digit in carrier identification code
Digit Four or Null	Fourth digit in carrier identification code (if there are four digits)
CARRIER SELECTION INFORMATION	
Carrier Selection Indicator	Indicates whether the carrier identification code was presubscribed or input
CHARGE NUMBER	
Nature of Address Indicator	This information may be used for billing. 00000001 - caller number 00000010 - no ANI, route to operator 00000011 - caller's national number 00000101 - route if 800, or route to operator 0000110 - no ANI 0000111 - route if 800 or route to operator
Odd/Even	Number of digits in calling number
Numbering Plan	Pass any information
Digits Field	The number of calling party
GENERIC ADDRESS	
Nature of Address Indicator	Pass any information
Odd/Even	Pass any information
Screening	Pass any information
Presentation Allowed/Restricted	Pass any information
Numbering Plan	Pass any information
Digits Field	Pass any information

TABLE 1-continued

Initial Address Message

Parameter Field Name	Description
ORIGINATING LINE INFORMATION	
Originating Line Information	Identifies particular types of calls, for example: 00000000 - normal call 00000111 - call from a restricted phone 00111111 - call from a cellular roamer
ORIGINAL CALLED NUMBER	
Nature of address Indicator	Pass any information
Odd/Even	Pass any information
Screening	Pass any information
Presentation Allowed/Restricted	Pass any information
Numbering Plan	Pass any information
Digits Field	Pass any information
REDIRECTING NUMBER	
Nature of Address Indicator	Pass any information
Odd/Even	Pass any information
Screening	Pass any information
Presentation Allowed/Restricted	Pass any information
Numbering Plan	Pass any information
Digits Field	Pass any information
REDIRECTION INFORMATION	
Redirection Indicator	Pass any information
Original Redirecting Reason	Pass any information
Redirection Counter	Pass any information
Redirection Reason	Pass any information
SERVICE CODE	
Service Code	Pass any information
TRANSIT NETWORK SELECTION	
Network Identification Plan	Identifies the number of digits in the carrier identification code (3 or 4)
Type of Network Identification	Type of network identification for transit network parameter
Digits 1,2,3,4	Carrier identification code of the international transit carrier
Circuit Code	Indicates how the call was dialed: 0001 - international call, no operator requested 0010 - international call, operator requested
HOP COUNTER	
Hop Counter	limits the number of times an IAM may transfer through a signaling point. If the count reaches the limit, release the call

Subsequent ISUP Message Processing

The processing of the IAM is discussed above. Those skilled in the art are will appreciate how other SS7 messages can be incorporated into the processing of the present invention. For example, the time an address complete message (ACM) is received is recorded in the call control block for billing and maintenance. Triggers can also be based on receipt of subsequent messages, such as the ACM. The process for the answer message (ANM) is much the same.

Cut-through is the time point at which the users are able to pass information along the call connection from end to end. Messages from the CCM to the appropriate network elements are required to allow for cut-through of the call. Typically, call connections include both a transmit path from the caller and a receive path to the caller, and cut through is

allowed on the receive path after the ACM is received and on the transmit path after the ANM is received.

Upon receipt of a release (REL) message, the CCM will write a time for the message to the call control block and check for triggers upon release (such as call re-originate). Additionally, any disabled echo canceller will be re-enabled, and the call control block will be used to create a billing record. Upon the receipt of a release complete message (RLC), the CCM will transmit messages directing tear down of the call path. It will clear its call specific processes and reuse the call connections for subsequent calls.

Additionally, suspend messages (SUS) and pass along messages (PAM) may be processed by the CCM. A suspend message (SUS) indicates that the called party has disconnected and a REL will follow if the called party does not re-connect with a specified time. A PAM is simply a message between signaling points and can contain a variety of information and be used for a variety of purposes.

The invention allows switching over an ATM fabric on a call by call basis. This allows efficient high capacity virtual connections to be exploited. Advantageously, the invention does not require signaling capability in an ATM switch. The invention does not require call processing capability in an ATM switch. This enables networks to implement ATM switching without these sophisticated ATM switches that support high volumes of calls. It also avoids the cost of these switches. The invention fully supports voice traffic and non-voice traffic. The invention supports services, such as N00, VPN, personal/terminal mobility, and voice messaging without requiring the service capability in an ATM switch. Relying on ATM cross-connects is advantageous because ATM cross-connects are farther advanced than ATM switches, and the cross-connects require less administrative support.

Those skilled in the art will appreciate that variations from the specific embodiments disclosed above are contemplated by the invention. The invention should not be restricted to the above embodiments, but should be measured by the following claims.

I claim:

1. A method of operating a telecommunications system to provide a call with a virtual connection wherein a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection for the call, wherein the system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer, the method comprising:

receiving the signaling for the call into the signaling processor;

processing the signaling for the call in the signaling processor to select the virtual connection;

generating new signaling in the signaling processor to identify the particular connection and the selected virtual connection;

transmitting the new signaling to the ATM interworking multiplexer;

receiving the user information for the call from the particular connection into the ATM interworking multiplexer;

converting the user information from the particular connection into ATM cells that identify the selected virtual connection in the ATM interworking multiplexer in response to the new signaling; and

transmitting the ATM cells from the ATM interworking multiplexer over the selected virtual connection.

2. The method of claim 1 wherein receiving the signaling for the call comprises receiving a call set-up message.

3. The method of claim 1 wherein receiving the signaling for the call comprises receiving a Signaling System #7 (SS7) initial address message (IAM).

4. The method of claim 1 wherein receiving user information for the call from the particular connection comprises receiving user information from a DS0 connection.

5. The method of claim 1 wherein receiving user information for the call comprises receiving voice information.

6. The method of claim 1 wherein selecting the virtual connection comprises selecting the virtual connection based on the dialed number.

7. The method of claim 1 wherein selecting the virtual connection comprises selecting the virtual connection based on N00 call processing.

8. The method of claim 1 wherein selecting the virtual connection comprises selecting the virtual connection based on virtual private network (VPN) call processing.

9. The method of claim 1 wherein selecting the virtual connection comprises selecting the virtual connection based on personal/terminal mobility service call processing.

10. The method of claim 1 wherein transmitting the ATM cells comprises transmitting the ATM cells on a SONET connection.

11. The method of claim 1 wherein processing the signaling for the call in the signaling processor further comprises processing the signaling to determine digital signal processing (DSP) requirements for the call, wherein generating new signaling for the call further comprises generating new signaling that identifies the DSP requirements for the call, and wherein the method further comprises implementing the DSP requirements for the call in the ATM interworking multiplexer in response to the new signaling.

12. The method of claim 11 wherein implementing the DSP requirements comprises echo control for the call.

13. The method of claim 11 wherein implementing the DSP requirements comprises encrypting the call.

14. The method of claim 11 wherein implementing the DSP requirements comprises adjusting a decibel level for the call.

15. The method of claim 1 wherein the particular connection and the virtual connection are bi-directional and other user information is transmitted in ATM cells over the virtual connection to the ATM interworking multiplexer for transmission to the user, the method further comprising:

receiving ATM cells for the call from the virtual connection into the ATM interworking multiplexer;

converting the other user information in the ATM cells from the virtual connection into a format suitable for the particular connection; and

transmitting the other user information from the ATM interworking multiplexer over the particular connection.

16. A method of operating a telecommunications system to provide a call with a narrowband connection wherein a user places the call by sending signaling for the call to the telecommunications system and the telecommunications system facilitates the call by transporting user information in ATM cells over a virtual connection, and wherein the system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer, the method comprising:

receiving the signaling for the call into the signaling processor;

processing the signaling for the call in the signaling processor to select the narrowband connection;

generating new signaling in the signaling processor to identify the virtual connection and the selected narrowband connection;

transmitting the new signaling to the ATM interworking multiplexer;

receiving the ATM cells for the call from the virtual connection into the ATM interworking multiplexer;

converting the ATM cells from the virtual connection into user information in narrowband format in the ATM interworking multiplexer in response to the new signaling; and

transmitting the user information from the ATM interworking multiplexer over the selected narrowband connection.

17. A method of operating a telecommunications system to provide a call with a virtual connection wherein a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over an access connection for the call, wherein the system comprises a plurality of access connections, a plurality of ATM interworking multiplexers connected to the access connections, a signaling processing system linked to the ATM interworking multiplexers, and an ATM cross-connect system connected to the ATM interworking multiplexers and configured to provide a plurality of virtual connections between the ATM interworking multiplexers, the method comprising:

providing the user with a first access connection to a first ATM interworking multiplexer;

receiving the signaling for the call into the signaling processing system;

processing the signaling for the call in the signaling processing system to select a virtual connection from the first ATM interworking multiplexer through the ATM cross-connect system to a second ATM interworking multiplexer and a second access connection to the second ATM interworking multiplexer;

generating, in the signaling processing system, a first new signal for the call that identifies the first access connection and the selected virtual connection, and a second new signal for the call that identifies the selected virtual connection and the second access connection;

transmitting the first new signal to the first ATM interworking multiplexer and the second new second new signal to the second ATM interworking multiplexer;

receiving the user information for the call from the first access connection into the first ATM interworking multiplexer;

converting the user information from the first access connection into ATM cells that identify the selected virtual connection in the first ATM interworking multiplexer in response to the first new signal;

transmitting the ATM cells from the first ATM interworking multiplexer through the ATM cross-connect system over the selected virtual connection to the second ATM interworking multiplexer;

converting the ATM cells that identify the selected virtual connection to user information for the second access connection in the second ATM interworking multiplexer in response to the second new signal;

transmitting the user information from the second ATM interworking multiplexer over the second access connection.

18. The method of claim **17** wherein receiving the signaling for the call comprises receiving a call set-up message.

19. The method of claim **17** wherein receiving the signaling for the call comprises receiving a Signaling System #7 (SS7) initial address message (IAM).

20. The method of claim **17** wherein receiving user information for the call from the first access connection comprises receiving user information from a DS0 connection.

21. The method of claim **17** wherein receiving user information for the call comprises receiving voice information.

22. The method of claim **17** wherein selecting the virtual connection comprises selecting the virtual connection based on the dialed number.

23. The method of claim **17** wherein selecting the virtual connection comprises selecting the virtual connection based on N00 call processing.

24. The method of claim **17** wherein selecting the virtual connection comprises selecting the virtual connection based on virtual private network (VPN) call processing.

25. The method of claim **17** wherein selecting the virtual connection comprises selecting the virtual connection based on personal/terminal mobility service call processing.

26. A method of operating a telecommunications system to provide a call with a virtual connection wherein a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over an access connection for the call, wherein the system comprises a plurality of access connections, a plurality of ATM interworking multiplexers connected to the access connections, a plurality of signaling processors linked to each other and the ATM interworking multiplexers, and an ATM cross-connect system connected to the ATM interworking multiplexers and configured to provide a plurality of virtual connections between the ATM interworking multiplexers, the method comprising:

providing the user with a first access connection to a first ATM interworking multiplexer;

receiving a first signal for the call into a first signaling processor;

processing the first signal in the first signaling processor to select a virtual connection for the call from the first ATM interworking multiplexer through the ATM cross-connect system to a second ATM interworking multiplexer and to select a point for the call connected to the second ATM interworking multiplexer;

generating a second signal in the first signaling processor that identifies the selected virtual connection and the point;

transmitting the second signal to a second signaling processor;

processing the second signal in the second signaling processor to select a second access connection for the call from the second ATM interworking multiplexer to the point;

generating a third signal in the first signaling processor that identifies the first access connection and the selected virtual connection;

transmitting the third signal to the first ATM interworking multiplexer;

generating a fourth signal in the second signaling processor that identifies the selected virtual connection and the second access connection;

transmitting the fourth signal to the second ATM interworking multiplexer;

receiving the user information for the call from the first access connection into the first ATM interworking multiplexer;

converting the user information from the first access connection into ATM cells that identify the selected virtual connection in the first ATM interworking multiplexer in response to the third signal;

transmitting the ATM cells from the first ATM interworking multiplexer through the ATM cross-connect system over the selected virtual connection to the second ATM interworking multiplexer;

converting the ATM cells that identify the selected virtual connection into user information suitable for the second access connection in the second ATM interworking multiplexer in response to the fourth signal; and

transmitting the user information from the second ATM interworking multiplexer over the second access connection to the point.

27. The method of claim **26** wherein receiving the first signal for the call comprises receiving a call set-up message.

28. The method of claim **26** wherein receiving the first signal for the call comprises receiving an Signaling System #7 (SS7) initial address message (IAM).

29. The method of claim **26** wherein receiving user information for the call from the first access connection comprises receiving user information from a DS0 connection.

30. The method of claim **26** wherein receiving user information for the call comprises receiving voice information.

31. The method of claim **26** wherein selecting the virtual connection comprises selecting the virtual connection based on the dialed number.

32. The method of claim **26** wherein selecting the virtual connection comprises selecting the virtual connection based on N00 call processing.

33. The method of claim **26** wherein selecting the virtual connection comprises selecting the virtual connection based on virtual private network (VPN) call processing.

34. The method of claim **26** wherein selecting the virtual connection comprises selecting the virtual connection based on personal/terminal mobility service call processing.

35. A telecommunications system to provide a call received over a particular connection with a virtual connection in response to signaling for the call, the system comprising:

a signaling processor operable to receive and process the signaling for the call to select the virtual connection for the call, and to generate and transmit new signaling that identifies the particular connection and the selected virtual connection;

an ATM interworking multiplexer operable to receive user information from the particular connection, convert the user information into ATM cells that identify the selected virtual connection in response to the new signaling, and to transmit the ATM cells from the ATM interworking multiplexer over the selected virtual connection; and

a link between the signaling processor and the ATM interworking multiplexer operable to transfer the new signaling from the signaling processor to the ATM interworking multiplexer.

36. The system of claim **35** further comprising an ATM cross-connect system connected to the ATM interworking multiplexer and configured to provide a plurality of virtual connections to the ATM interworking multiplexer.

37. A telecommunications system for transporting user information for a call over a virtual connection selected for the call in response to a first signal for the call, the system comprising:

a plurality of access connections operable to receive and transmit user information;

a plurality of ATM interworking multiplexers connected to the access connections and operable and to transmit and receive user information over the access connections and to transmit and receive ATM cells over a plurality of virtual connections;

an ATM cross-connect system connected to the ATM interworking multiplexers and configured to provide the plurality of virtual connections between the ATM interworking multiplexers;

a signaling processing means for receiving and processing the first signal for the call to identify a first access connection used for the call, to identify a first ATM interworking multiplexer connected to the first access connection, to select a virtual connection for the call from the first ATM interworking multiplexer to a second ATM interworking multiplexer, and to select a second access connection connected to the second ATM interworking multiplexer;

a signaling generation means coupled to the signaling processing means for generating a second signal for transmission to the first ATM interworking multiplexer that identifies the first access connection and the virtual connection, and for generating a third signal for transmission to the second ATM interworking multiplexer that identifies the virtual connection and the second access connection;

a signaling transfer means for transferring the second signal to the first ATM interworking multiplexer and for transferring the third signal to the second ATM interworking multiplexer;

a first adaption means in the first ATM interworking multiplexer for receiving the second signal, and in response, converting user information from the first access connection into ATM cells that identify the virtual connection and converting ATM cells from the virtual connection into user information suitable for the first access connection;

a second adaption means in the second ATM interworking multiplexer for receiving the third signal, and in response, converting the ATM cells from the virtual connection into user information suitable for the second access connection and converting user information from the second access connection into ATM cells that identify the virtual connection.

38. The system of claim **37** wherein the first signal is a Signaling System #7 (SS7) initial address message (IAM).

39. The system of claim **37** wherein the first access connection is a DS0 connection.

40. The system of claim **37** wherein the user information is voice information.

41. The system of claim **37** wherein the virtual connection is selected based on the dialed number.

42. The system of claim **37** wherein the virtual connection is selected based on N00 call processing.

43. The system of claim **37** wherein the virtual connection is selected based on virtual private network (VPN) call processing.

44. The system of claim **37** wherein the virtual connection is selected based on personal/terminal mobility service call processing.

45. A method of operating a telecommunications system to provide a call with a virtual connection wherein a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection for the call, wherein the system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer, the method comprising:

receiving the signaling for the call into the signaling processor wherein the signaling processor is external to any switch;

processing the signaling for the call in the signaling processor to select the virtual connection;

generating new signaling in the signaling processor to identify the particular connection and the selected virtual connection;

transmitting the new signaling to the ATM interworking multiplexer;

receiving the user information for the call from the particular connection into the ATM interworking multiplexer;

converting the user information from the particular connection into ATM cells that identify the selected virtual connection in the ATM interworking multiplexer in response to the new signaling; and

transmitting the ATM cells from the ATM interworking multiplexer over the selected virtual connection.

46. A method of operating a telecommunications system to provide a call with a virtual connection wherein a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection for the call, wherein the system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer, the method comprising:

receiving the signaling for the call into the signaling processor;

processing the signaling for the call in the signaling processor to select the virtual connection;

generating new signaling in the signaling processor to identify the particular connection and the selected virtual connection;

transmitting the new signaling to the ATM interworking multiplexer;

receiving the user information for the call from the particular connection into the ATM interworking multiplexer;

converting the user information from the particular connection into ATM cells that identify the selected virtual connection in the ATM interworking multiplexer in response to the new signaling wherein the virtual connection is not used for other calls until the call is released; and

transmitting the ATM cells from the ATM interworking multiplexer over the selected virtual connection.

47. A telecommunications system to provide a call received over a particular connection with a virtual connection in response to signaling for the call, the system comprising:

a signaling processor that is not coupled to a switch matrix and that is operable to receive and process the signaling for the call to select the virtual connection for the call, and to generate and transmit new signaling that identifies the particular connection and the selected virtual connection;

an ATM interworking multiplexer operable to receive user information from the particular connection, convert the user information into ATM cells that identify the selected virtual connection in response to the new signaling, and to transmit the ATM cells from the ATM interworking multiplexer over the selected virtual connection; and

a link between the signaling processor and the ATM interworking multiplexer operable to transfer the new signaling from the signaling processor to the ATM interworking multiplexer.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,991,301
DATED : November 23, 1999
INVENTOR(S) : Joseph Michael Christie

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [63], **Related U.S. Application Data**, delete "Continuation-in-part of application No. 08/238,605, May 5, 1994, abandoned."

Signed and Sealed this

Fourth Day of January, 2005

JON W. DUDAS
Director of the United States Patent and Trademark Office

EXHIBIT 35

REDACTED IN ITS ENTIRETY

EXHIBIT 36

Page 1

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

Case No. 17-CV-1734-RGA

REMOTE DEPOSITION OF DR. MICHAEL FRENDO
May 29, 2020

SPRINT COMMUNICATIONS COMPANY, L.P.,

Plaintiff,

v.

CHARTER COMMUNICATIONS, INC., CHARTER COMMUNICATIONS HOLDINGS, LLC, SPECTRUM MANAGEMENT HOLDING COMPANY, LLC, CHARTER COMMUNICATIONS OPERATING, LLC, BRIGHT HOUSE NETWORKS, LLC,
Defendants.

A P P E A R A N C E S

For the Plaintiff: THOMAS M. PATTON, ESQ.
Shook, Hardy & Bacon, L.L.P.
222 Delaware Avenue
Suite 1101
Wilmington, DE 19801
302-252-0920

For the Defendants: DANIEL REISNER, ESQ.
Arnold, Porter, Kaye, Scholer, LLP
250 West 55th Street
New York, NY 10019
212-836-8132

Page 2

Remote Deposition of DR. MICHAEL FRENDO, the Witness herein, called by the Plaintiff in the above-entitled matter on Friday, May 29, 2020, commencing at the hour of 9:02 a.m., at Boulder, Colorado, before Theresa L. Mendez, a Registered Professional Reporter and Notary Public for the State of Colorado, said deposition being taken pursuant to Notice and the Colorado Rules of Civil Procedure.

I N D E X

E X H I B I T S

(Exhibits indexed and attached to original and copy transcripts.)

Page 3

P R O C E E D I N G S

MR. REISNER: Standard order. We're not going to order the video at this point.

THE COURT REPORTER: So this is Theresa Mendez. I'm a shorthand reporter. And this deposition is being held via telephone equipment.

The witness and the reporter are not in the same room. The witness will be sworn in remotely pursuant to agreement of all parties. The parties stipulate that the testimony is being given as if the witness was sworn in person.

Does everyone agree?

MR. PATTON: Yes.

MR. REISNER: Yes.

DR. MICHAEL FRENDO,

having been first duly sworn, testified on oath as follows:

EXAMINATION

BY MR. PATTON:

Q. Thank you. Hi, Dr. Frendo. As she said, my name is Thomas. I represent Sprint. Would you please state your name for the record again.

A. Michael Frendo.

Q. Would you please spell your name for the record.

Page 4

A. M-I-C-H-A-E-L, F-R-E-N-D-O.

Q. Thanks. Where do you currently live?

A. I currently live in Boulder, Colorado.

Q. What's your address?

A. 9044 Jason Court, Boulder, Colorado 80303.

Q. Have you ever been deposed before?

A. No.

Q. I will start off with a few ground rules. It's pretty simple. I'm here to ask you some questions and you'll be answering those questions.

Do you understand that?

A. Yes.

Q. If you don't understand my question, just please let me know and I will try to rephrase it. Fair?

A. That's fair.

Q. If you answer a question, I will assume that you understood it. Okay?

A. That's fair.

Q. So in other words, unless you tell me otherwise, I'll assume you understood my question. Okay?

At certain times today, your attorney may object to the questions I ask, but you're to answer the questions unless your attorney specifically

A. They participate in setting up calls, not connections.

Q. Okay. What about eMTA? Do you agree that eMTA participates in setting up calls?

A. No. They take the information that they have, which is a dialed number and they send it to control process somewhere that takes responsibility for setting up the calls.

They're done that way. Whatever they came in, they say, Hey, can you figure this out for me because I have no idea what to do with it.

Q. And you wouldn't consider in sending it to the control processor somewhere participating in setting up the call?

A. No, because it's not sending it to the control processor somewhere. What you're doing is you're looking at the table -- at the configuration of the eMTA, and it says, send it to this address. That's all you do.

You have no idea. It's a very simple process. You gather the digits, form a message, send it to this address.

It doesn't go look for some other address. It just has one. And if the first one fails, then we have a backup one. They're two fixed addresses.

There's no routing involved. It's all about the IP network. There's no intelligence really involved. It's simply a passing of the information to a higher entity, the control processor to make that decision.

Q. Would you agree that eMTAs and media gateways, at least, assist in selecting the routing code?

A. No. Neither one of them does.

Q. So looking further in your report, is it fair to say that a lot of your criticisms of Dr. Wicker's rebuttal, is that a lot of these standards were not final complete standards as of May 1994?

A. I believe some of them were relevant.

Q. Okay. Breaking those apart. You would agree that a standard doesn't have to be final and complete for it to be useful to a person of skill in the art, fair?

A. I agree.

Q. And like we just discussed, standards do lag behind the marketplace in what a person can actually do?

A. I agree.

Q. What's your basis for saying that the

FORE-ASX -- for the record, I'll spell that out.

What's your basis for saying the FORE, F-O-R-E, ASX-100 could not set up calls?

A. There's a few things. First, the ASX was built as a land background product. So it's really built to set up connections between elements on land for land backup. That's the first issue.

The second issue is the signaling set of the calls has to come from the connections, the workstations. The only way to connect to an ASX was through a workstation interface which was also provided by FORE. That's the second piece. In and of itself was proprietary. Doesn't mean it didn't set up access, but it was proprietary, so therefore not widely applicable for themselves. It's just that.

And then the next piece is, it has no voice -- it has no voice adaptation capability at all. The initial product had support for AL-3, 4 and 5, no support for AL-1 or 2, which both were required for voice capability.

So -- and if you look at the construction of the actual example, again which is in Figure 3, right. The way Figure 3 is set up, you would have to put a MUX in front of the switch, which is the

SX-100. Because -- and the MUX would have to do the signaling to the SX-100 to set up the connection.

And nothing in the actual disclosure and nothing in the invention creates a connection between the call control processor and the MUX. That connection doesn't exist.

It would not be appropriate. For it to work, you would have to redesign the entire system. But for all those reasons, it doesn't solve this problem.

MR. REISNER: Theresa, do you happen to know how much time we've been on the clock?

(Conversation off the record.)

MR. REISNER: I understand this deposition should in no way have taken seven hours in the first place, so why don't you get on with it.

MR. PATTON: Okay.

Q. (BY MR. PATTON) You agree that these two reports, which are Exhibit 2 and Exhibit 3, contain your full opinions regarding the topics with which you've been asked to offer opinions in this case?

A. Yes.

Q. May I quickly direct your attention to page 11 of your reply of that same Exhibit 3. Page 11, paragraph 32 of your reply, which is

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Exhibit 30.
A. I'm there. Yep.
Q. So the title of this section is: Ease of Modifying Functions of an eMTA media gateway Controller, and media gateway.
Did I read that correctly?
A. Yes, you did.
Q. Is this portion of your report responsive to Dr. Wicker's invalidity rebuttal report?
A. No. This was in response to -- request of what it would take to modify, you know, described to me by legal team by Almeroth. What would it take -- my opinions of what would it take to modify things in these ways.
Q. So this is not responsive to anything in Dr. Wicker's invalidity rebuttal report, as you understand?
A. I don't know. Maybe -- again, what I was asked directly by counsel and by Dr. Almeroth, if these things were possible, and if so, how much effort would they get.
Q. Did you consider Dr. Wicker's infringement report?
A. No. Again, it may have been considered by counsel, it was not considered by me. I was

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informing, again, a fairly well-defined request from the doctor.
Q. And this portion of your report deals with the 2002 to 2016 time frame; is that fair?
A. That's my understanding, yes.
Q. Is there anything in your opening report about the 2002 to 2016 time frame?
A. No.
Q. Do you know whether there was anything in Dr. Wicker's rebuttal report directly related to the 2002 to 2016 time frame?
A. I would say, if it was referring to Dr. Almeroth, I probably didn't read it. So it could have been there. But if it was referring to the things I have said, then I read that portion.
Q. And so my understanding --
A. I don't know -- and the portion I read, no.
Q. Just to clean that up. In the portion you read, where Dr. Wicker was responding to your opening opinion, your opening report, there's nothing about the 2002 to 2016 time frame, correct?
A. I don't believe so.
Q. Okay. So this is a completely separate opinion from your opening report?
A. That's fair to say.

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Q. And you say that, as of 2002, a person of skill in the art would have been readily able to make various hardware and software modifications; is that fair?
A. No. I specifically said software modifications.
Q. Software modifications would need to be made?
A. I don't believe any hardware modifications would need to be made.
Q. And that's based on your own opinion, not based on any documents or supporting --
A. Again, it's based on experience.
Q. Okay. If you can pull out Exhibit 4 to your deposition, which is 424, 2020 rebuttal report.
A. Yep. I have it.
Q. Do you have Exhibit 4?
A. Yes.
Q. What is Exhibit 4?
A. Exhibit 4 is a rebuttal expert report, if I could find -- rebuttal to the rebuttal.
Q. Okay. And, again, this report reflects your opinions regarding certain modifications that you believe -- strike that.
This report reflects your opinions

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regarding the difficulty or ease with which certain modifications could have been to a voicemail system; is that fair?
A. Not fair. It's modifications to a system that sends the call to voicemail, not the voicemail system itself. Okay.
MR. REISNER: Thomas, I'm just going to give you a warning. You've got to complete this in five minutes or I'm going to ask Theresa to compute the time.
MR. PATTON: Okay.
Q. (BY MR. PATTON) Could you turn to page 1 of your report in paragraph 4?
A. Yep.
Q. It says that you reviewed all of these documents in Exhibit A to the deposition, three different documents.
Did you review all these?
A. These notes -- some documents I may object, the 850. There are thousands. I wouldn't say I read them deeply.
Q. Okay. You didn't review Dr. Wicker's opening infringement report; is that fair?
A. That is correct.
Q. Okay.

EXHIBITS 37-39

REDACTED IN THEIR ENTIRETY

EXHIBIT 40

EXHIBIT 2
(232 Pages)

U.S. Patent 5,991,301
Complete File History

Relationship: Parent/Grandparent of Asserted '429, '084, '064
Immediate Parent: None
Application Number: 08/525,897
Filing Date: September 8, 1995
Issue Date: November 23, 1999

Basic Filing Fee		$730.00
Total Number of Claims, (less 20)	42 x $22.00 =	$924.00
Number of Independent Claims, (less 3)	6 x $76.00 =	$456.00
Total Filing Fee		$2,110.00
Fee for Recording Assignment		$ 0.00
		$
	Total:	$2,110.00

Respectfully submitted,

9-8-95
Date

By: [signature]

Michael J. Setter, Patent Atty.
Reg. No. 37,936
Tel: (913) 624-5194
Fax: (913) 624-6388

SPRINT COMMUNICATIONS COMPANY L.P.
8140 Ward Parkway
Fifth Floor
MS: MOKCMP0506
Kansas City, Missouri 64114

BROADBAND TELECOMMUNICATIONS SYSTEM

Cross-Reference to Related Application

This application is a continuation-in-part of prior application serial number 08/238,605, entitled "Method, System, and Apparatus for Telecommunications Control", filed May 5, 1994, currently pending, and incorporated by reference into this application.

Background

At present, Asynchronous Transfer Mode (ATM) technology is being developed to provide broadband switching capability. Some ATM systems have used ATM cross-connects to provide virtual connections. Cross-connect devices do not have the capacity to process signaling. Signaling refers to messages that are used by telecommunications networks to set-up and tear down calls. Thus, ATM cross-connects cannot make connections on a call by call basis. As a result, connections through cross-connect systems must be pre-provisioned. They provide a relatively rigid switching fabric. Due to this limitation, ATM cross-connect systems have been primarily used to provide dedicated connections, such as permanent virtual circuits (PVCs) and permanent virtual paths (PVPs). But, they do not to provide ATM switching on a call by call basis as required to provide switched virtual circuits (SVCs) or switched virtual paths (SVPs). Those skilled in the art are well aware of the efficiencies created by using SVPs and SVCs as opposed to PVCs and PVPs. SVCs and SVPs utilize bandwidth more efficiently.

ATM switches have also been used to provide PVCs and PVPs. Since PVCs and PVPs are not established on a call-by-call basis, the ATM switch does need to use its call processing or signaling capacity. ATM switches require both signaling capability and call processing capability to provide SVCs and SVPs. In order to achieve virtual connection switching on a call by call basis, ATM switches are being developed that can process calls in response to signaling to provide virtual connections for each call. These systems cause problems because they must be very sophisticated to support current networks. These ATM switches must process high volumes of calls and transition legacy services from existing networks. An example would be an ATM switch that can handle large numbers of POTS, 800, and VPN

calls. This generation of sophisticated ATM switches is not yet mature and should be expensive when they are first deployed.

Currently, ATM multiplexers are being developed that can interwork traffic into ATM cells and multiplex the cells for transport over an ATM network. One example of an application of these muxes is provided by T1 transport over an ATM connection. Traffic that leaves the switch in T1 format is muxed into ATM cells for transport over a high speed connection. Before the cells reach another switch, they are converted back into the T1 format. Thus, the ATM mux is used for high speed transport. The ATM mux is not used to select virtual connections on a call-by-call basis. Unfortunately, there is not a telecommunications system that can provide ATM switching on a call by call basis without relying on the call processing and signaling capability of an ATM switch.

Summary

The invention includes a method of operating a telecommunications system to provide a call with a virtual connection. The method is for use when a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection. The system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer. The method comprises receiving the signaling for the call into the signaling processor, processing the signaling to select the virtual connection, generating new signaling to identify the particular connection and the selected virtual connection, and then transmitting the new signaling to the ATM interworking multiplexer. The method also includes receiving the user information for the call from the particular connection into the ATM interworking multiplexer, converting the user information into ATM cells that identify the selected virtual connection in response to the new signaling, and transmitting the ATM cells over the selected virtual connection. The signaling for the call could be a call set-up message, such a Signaling System #7 (SS7) initial address message (IAM). The method could also include applying digital signal processing (DSP) to the call in the multiplexer in accord with DSP requirements selected by the signaling processor. DSP requirements could include echo control or encryption.

The invention also includes a telecommunications system to provide a call with a virtual connection in response to signaling for the call. The system comprises a signaling processor to receive and process signaling to select the virtual connection for the call, and to generate and transmit new signaling that identifies the selected virtual connection. The system includes an ATM interworking multiplexer to receive user information from a connection, convert the user information into ATM cells that identify the selected virtual connection, and transmit the ATM cells over the selected virtual connection. The system could also include an ATM cross-connect system connected to the ATM interworking multiplexer and configured to provide a plurality of virtual connections to the ATM interworking multiplexer.

The invention also includes an ATM interworking multiplexer for providing calls with virtual connections in response to signaling for each of the calls. The multiplexer comprises an access interface to receive user information for each call from a particular connection. It also includes a control interface to receive signaling for each call that identifies the particular connection and a virtual connection for that call. It also includes an ATM adaption processor to convert user information from the particular connection for each call into ATM cells that identify the virtual connection for that call. The multiplexer also includes an ATM interface to transmit the ATM cells for each call over the virtual connection. The multiplexer could include a digital signal processor to apply digital signal processing to the user information for each call. The processing could include echo control and encryption.

In various embodiments, the invention accepts calls placed over DS0 voice connections and provides virtual connections for the calls. In this way, broadband virtual connections can be provided to narrowband traffic on a call-by-call basis without requiring the call processing and signaling capability of an ATM switch.

Brief Description of the Drawings

Figure 1 is a block diagram of a version of the present invention.

Figure 2 is a block diagram of a version of the present invention.

a ~~Figure 3 is a block diagram of a version~~ Figures 3A and 3B are block diagrams of versions of the present invention.

Figure 4 is a block diagram of a version of the present invention.

EXHIBIT 41

09/439033 U.S. PTO 11/12/99

ISSUE CLASSIFICATION

Class	Subclass
370	466

[redacted]

PATENT NUMBER
6343084

U.S. UTILITY PATENT APPLICATION

O.I.P.E.	PATENT DATE
KW SCANNED CK4 Q.A. DMW	JAN 29 2002

SECTOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
	370	395	2664 2734	Patel, A.

APPLICATION NO.	CONT/PRIOR	CLASS	SUBCLASS	ART UNIT	EXAMINER
09/439033	YES	370	~~474~~ 466	~~2708~~ 2662	Patel

APPLICANTS: JOSEPH MICHAEL CHRISTIE

TITLE: BROADBAND TELECOMMUNICATIONS SYSTEM

Certificate FEB 22 2005 of Correction

Certificate JAN 27 2004 of Correction

PTO-2040 12/99

ISSUING CLASSIFICATION

ORIGINAL		CROSS REFERENCE(S)						
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
370	466							
INTERNATIONAL CLASSIFICATION								
H04J	3/16							
H04J	3/22							
	/							
	/							
	/							

☐ Continued on Issue Slip Inside File Jacket

☒ TERMINAL DISCLAIMER	DRAWINGS			CLAIMS ALLOWED	
	Sheets Drwg.	Figs. Drwg.	Print Fig.	Total Claims	Print Claim for O.G.
	12	12	2	16	1

☐ a) The term of this patent subsequent to ____________ (date) has been disclaimed.

(Assistant Examiner) (Date)

NOTICE OF ALLOWANCE MAILED: 7-26-01

☒ b) The term of this patent shall not extend beyond the expiration date of U.S Patent No. 5,991,301.

Ajit Patel
Primary Examiner
(Primary Examiner) 7/22/01 (Date)

ISSUE FEE

Amount Due	Date Paid
$1240.00	10-1-01

☐ c) The terminal ____ months of this patent have been disclaimed.

Jay Dobbs (Legal Instruments Examiner) 7/30/01 (Date)

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Abstract

The invention is a system for providing virtual connections through an ATM interworking multiplexer on a call-by-call basis. A signaling processor receives signaling for a call and selects the virtual connection for the call. The signaling processor generates new signaling that identifies the selection and transfers the new signaling to the ATM interworking multiplexer that accepted the access connection for the call. The multiplexer converts user information from the access connection into ATM cells for transmission over the virtual connection in accord with the new signaling.

BROADBAND TELECOMMUNICATIONS SYSTEM

Cross-Reference to Related Applications

This application is a continuation of pending United States patent application number 08/525,897, entitled "Broadband Telecommunications System", filed on September 8, 1995, now U.S. Pat. No. 5,991,301 which is incorporated by reference into this application, and which is a continuation-in-part of United States patent number 5,825,780 entitled "Method, System, and Apparatus for Telecommunications Control", which is incorporated by reference into this application, and which is a continuation of United States patent application number 08/238,605, filed 5/5/94, abandoned.

Background

At present, Asynchronous Transfer Mode (ATM) technology is being developed to provide broadband switching capability. Some ATM systems have used ATM cross-connects to provide virtual connections. Cross-connect devices do not have the capacity to process signaling. Signaling refers to messages that are used by telecommunications networks to set-up and tear down calls. Thus, ATM cross-connects cannot make connections on a call by call basis. As a result, connections through cross-connect systems must be pre-provisioned. They provide a relatively rigid switching fabric. Due to this limitation, ATM cross-connect systems have been primarily used to provide dedicated connections, such as permanent virtual circuits (PVCs) and permanent virtual paths (PVPs). But, they do not to provide ATM switching on a call by call basis as required to provide switched virtual circuits (SVCs) or switched virtual paths (SVPs). Those skilled in the art are well aware of the efficiencies created by using SVPs and SVCs as opposed to PVCs and PVPs. SVCs and SVPs utilize bandwidth more efficiently.

ATM switches have also been used to provide PVCs and PVPs. Since PVCs and PVPs are not established on a call-by-call basis, the ATM switch does need to use its call processing or signaling capacity. ATM switches require both signaling capability and call processing capability to provide SVCs and SVPs. In order to achieve virtual connection switching on a call by call basis, ATM switches are being developed that can process calls in response to signaling to provide virtual connections for each call. These systems cause problems because they must be

very sophisticated to support current networks. These ATM switches must process high volumes of calls and transition legacy services from existing networks. An example would be an ATM switch that can handle large numbers of POTS, 800, and VPN calls. This generation of sophisticated ATM switches is not yet mature and should be expensive when they are first deployed.

Currently, ATM multiplexers are being developed that can interwork traffic into ATM cells and multiplex the cells for transport over an ATM network. One example of an application of these muxes is provided by T1 transport over an ATM connection. Traffic that leaves the switch in T1 format is muxed into ATM cells for transport over a high speed connection. Before the cells reach another switch, they are converted back into the T1 format. Thus, the ATM mux is used for high speed transport. The ATM mux is not used to select virtual connections on a call-by-call basis. Unfortunately, there is not a telecommunications system that can provide ATM switching on a call by call basis without relying on the call processing and signaling capability of an ATM switch.

Summary

The invention includes a method of operating a telecommunications system to provide a call with a virtual connection. The method is for use when a user places the call by sending signaling for the call to the telecommunications system and by transmitting user information to the telecommunications system over a particular connection. The system comprises an ATM interworking multiplexer and a signaling processor linked to the ATM interworking multiplexer. The method comprises receiving the signaling for the call into the signaling processor, processing the signaling to select the virtual connection, generating new signaling to identify the particular connection and the selected virtual connection, and then transmitting the new signaling to the ATM interworking multiplexer. The method also includes receiving the user information for the call from the particular connection into the ATM interworking multiplexer, converting the user information into ATM cells that identify the selected virtual connection in response to the new signaling, and transmitting the ATM cells over the selected virtual connection. The signaling for the call could be a call set-up message, such a Signaling System #7 (SS7) initial address message (IAM). The method could also include applying digital signal

processing (DSP) to the call in the multiplexer in accord with DSP requirements selected by the signaling processor. DSP requirements could include echo control or encryption.

The invention also includes a telecommunications system to provide a call with a virtual connection in response to signaling for the call. The system comprises a signaling processor to receive and process signaling to select the virtual connection for the call, and to generate and transmit new signaling that identifies the selected virtual connection. The system includes an ATM interworking multiplexer to receive user information from a connection, convert the user information into ATM cells that identify the selected virtual connection, and transmit the ATM cells over the selected virtual connection. The system could also include an ATM cross-connect system connected to the ATM interworking multiplexer and configured to provide a plurality of virtual connections to the ATM interworking multiplexer.

The invention also includes an ATM interworking multiplexer for providing calls with virtual connections in response to signaling for each of the calls. The multiplexer comprises an access interface to receive user information for each call from a particular connection. It also includes a control interface to receive signaling for each call that identifies the particular connection and a virtual connection for that call. It also includes an ATM adaption processor to convert user information from the particular connection for each call into ATM cells that identify the virtual connection for that call. The multiplexer also includes an ATM interface to transmit the ATM cells for each call over the virtual connection. The multiplexer could include a digital signal processor to apply digital signal processing to the user information for each call. The processing could include echo control and encryption.

In various embodiments, the invention accepts calls placed over DS0 voice connections and provides virtual connections for the calls. In this way, broadband virtual connections can be provided to narrowband traffic on a call-by-call basis without requiring the call processing and signaling capability of an ATM switch.

Brief Description of the Drawings

Figure 1 is a block diagram of a version of the present invention.

Figure 2 is a block diagram of a version of the present invention.

Figure 3 is a block diagram of a version of the present invention.

EXHIBITS 42 - 48

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